PROJECT MANUAL

WETUMPKA WATER WORKS & SEWER BOARD

Wetumpka, Alabama

for

CWSRF WASTEWATER TREATMENT PLANT IMPROVEMENTS

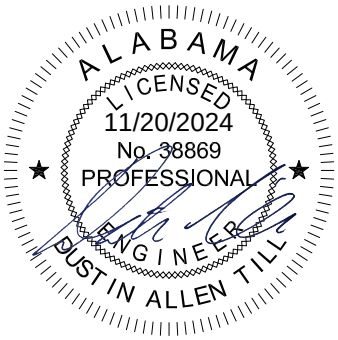
(SRF)

SRF Project No: CS010331-04

VOLUME II

NOVEMBER 2024

CONSTRUCTION DOCUMENTS



Prepared By

GMC

Goodwyn Mills Cawood, LLC
2660 EastChase Lane, Suite 200
Montgomery, AL 36117
T 334.271.3200
www.gmcnetwork.com

GMC PROJECT NUMBER: CMGM230096(1)

OWNERSHIP OF DOCUMENTS AND DISCLAIMER

The Project Manual, Technical Specifications, Drawings, and all other documents relating to this project have been prepared for this individual and particular project, and for the exclusive use of the original Owner, developer or other party so indicated.

Actual project conditions and as-built conditions may vary significantly. Changes made during bidding, negotiations, construction, due to additions or deletions of portions of this project, and/or for other reasons, may not be indicated in these documents.

These documents may not be used or relied upon as a certification of information indicated, or used for any other project, by any third parties or other parties, for any purpose whatsoever, without the prior written consent of Goodwyn Mills Cawood, LLC, or prior to receipt of mutually agreed to compensation paid to Goodwyn Mills Cawood, LLC, therefor.

Goodwyn Mills Cawood, LLC
2660 EastChase Lane, Suite 200
Montgomery, AL 36117
and
Andalusia, Alabama
Auburn, Alabama
Birmingham, Alabama
Daphne, Alabama
Eufaula, Alabama
Huntsville, Alabama
Mobile, Alabama
Vernon, Alabama

Pensacola, Florida
Sarasota, Florida
Tampa, Florida
Atlanta, Georgia
Augusta, Georgia
Brunswick, Georgia
Savannah, Georgia
New Orleans, Louisiana
Charlotte, North Carolina
Charleston, South Carolina
Columbia, South Carolina
Greenville, South Carolina
Brentwood, Tennessee
Nashville, Tennessee

CWSRF WASTEWATER TREATMENT PLANT IMPROVEMENTS

FOR THE

WETUMPKA WATER WORKS & SEWER BOARD
WETUMPKA, ALABAMA

SRF PROJECT NO. CS010460-06
GMC PROJECT NO. CMGM230096(1)

TABLE OF CONTENTS

VOLUME I

BID AND CONTRACT DOCUMENTS

00940	Work Change Directive
00941	Change Order
00942	Field Order

VOLUME II

DIVISION 01 – GENERAL REQUIREMENTS

01 1000	Summary of Work
01 2100	Allowances
01 2500	Substitution of Major Equipment Items & Products
01 2600	Contract Modification Procedures
01 2900	Payment Procedures
01 2900A	Contractor Progress Lien Waiver
01 3100	Project Management and Coordination
01 3200	Construction Progress Documentation
01 3300	Submittal Procedures
01 4000	Quality Requirements
01 4010	Materials Testing
01 4200	References
01 5000	Temporary Facilities and Controls
01 6000	Project Requirements
01 7000	Execution and Closeout Requirements
01 7823	Operation and Maintenance Data
01 7839	Project Record Documents
01 7900	Demonstration and Training
01 8100	Geotechnical Data

DIVISION 02 - EXISTING CONDITIONS

02 4119	Selective Demolition

DIVISION 03- CONCRETE

03 2000	Anchorage in Concrete
03 3000	Cast-in-Place Concrete
03 6000	Grouting

DIVISION 04 (NOT USED)

DIVISION 05 – METALS

05 1200	Structural Steel
05 2100	Steel Joist Framing
05 4000	Aluminum Handrail
05 5000	Metal Fabrications
05 5119	Metal Grating Stairs
05 5213	Pipe and Tube Railings
05 5313	Bar Gratings
05 5316	Plank Gratings
05 6000	Aluminum Hatches

DIVISION 06 (NOT USED)

DIVISION 07 – THERMAL AND MOISTURE PROTECTION

07 9200	Joint Sealants

DIVISION 08 (NOT USED)

DIVISION 09 – FINISHES

09 9600	High-Performance Coatings
09 9610	Epoxy Lining System for Concrete Structures

DIVISIONS 10 – SPECIALTIES

10 1400	Signage
10 4416	Fire Extinguishers

DIVISION 11-25 (NOT USED)

DIVISION 26 – ELECTRICAL

26 0005	Basic Electrical Materials and Methods
26 0519	Power Conductors and Cables 51V-600V
26 0526	Grounding
26 0533	Raceways
26 0534	Outlet Boxes, Junction Boxes, Wireways
26 0553	Electrical Identification

26 2419	Motor Control Devices
26 2726	Wiring Devices
26 2816	Safety Switches and Fuses
26 2900	Manufactured Control Panels
26 2923	Variable Frequency Drives
26 4400	Electrical Heating Tracing Systems
27 0500	Auxiliary System Cables, 0-50V
27 6000	SCADA System
27 6005	Instrumentation

DIVISION 27-30 (NOT USED)

DIVISION 31 – EARTHWORK

31 0516	Aggregates for Earthwork
31 200	Earth Moving

DIVISIONS 32 – 39 (NOT USED)

DIVISION 40 – PROCESS INTERCONNECTIONS

40 0506	Couplings Adapters Specials for Process Piping
40 0507	Hangers and Supports for Process Piping
40 0531	Thermoplastic Process Pipe
40 0551	Common Requirements for Process Valves
40 0553	Identification for Process Piping
40 0557	Actuators for Process Valves and Gates
40 0559	Stainless Steel Slide Gates
40 0561	Gate Valves
40 0563	Ball Valves
40 0564	Butterfly Valves
40 7023	Process Control Narratives
40 7213	Ultrasonic Level Meters
40 7313	Pressure & Differential Pressure Gauges

DIVISION 41 MATERIAL PROCESSING & HANDLING EQUIPMENT

41 2224	Electrified Hoist

DIVISION 42 (NOT USED)

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

43 1133	Rotary Screw Blowers

43 2210	Open Flight Archimedes Screw Pumps
43 2215	Tube Mounted Achimedes Screw Pumps
43 4146	Vertical Polyethylene Tanks and Accessories

DIVISIONS 44 – 45 (NOT USED)

DIVIONS 46 – WATER AND WASTEWATER EQUIPMENT

46 0553	Identification for Water and Wastewater Equipment
46 2115	Mechanical Screen & Compacting Equipment
46 3341	Liquid Chemical Feed Systems
46 3366	Liquid Chemical Transfer Pumps
46 4381	FRP Weirs
46 5146	Fine Bubble Diffusers

TECHNICAL SPECIFICATIONS

FOR

CWSRF WASTEWATER TREATMENT PLANT IMPROVEMENTS

FOR THE

WETUMPKA WATER WORKS AND SEWER BOARD

GMC PROJECT NO. CMGM23-0096(1)
CWSRF PROJECT NO. CS010331-04

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 01 10 00 - SUMMARY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Project Information.
2. Work Covered by Contract Documents.
3. Work Sequence.
4. Contractor-Furnished and Installed Products.
5. Work by Owner.
6. Access to Site.
7. Coordination with Occupants.
8. Work Restrictions.
9. Adverse Weather.
10. Specification and Drawing Conventions.
11. Warranties.
12. Construction Sequencing

B. Related Requirements:

1. Section 01 50 00 - Temporary Facilities and Controls for limitations and procedures governing temporary use of Owner's facilities.

1.2 PROJECT INFORMATION

A. Project Identification: CWSRF Wastewater Treatment Facility Improvements

1. Project Location: Wetumpka, Alabama.

B. Owner: Wetumpka Water Works and Sewer Board

1. Owner's Representative(s): Ronnie Windham, General Manager

C. Engineer: Goodwyn Mills & Cawood; Montgomery, Alabama.

D. Engineer’s Consultants: The Engineer has retained the following design professionals who have prepared designated portions of the Contract Documents:

1. Electrical Engineer – Jackson Renfroe & Associates; Birmingham, AL.

E. Contractor: TBD.

1.3 WORK COVERED BY CONTRACT DOCUMENTS

A. The Work of Project is defined by the Contract Documents and consists of the following:

1. The construction and modifications generally consist of the following:

a. Removal and Replacement of Influent Screw Pumps and Influent Lift Station Improvements (Additive Alternate No. 1).
b. Removal and Replacement of RAS pumps and electric hoists.
c. Headworks improvements including new mechanical screen and washer/compactor.
d. Removal of Existing and Replacement of Aeration Basin Effluent Weirs with new FRP V-Notch Weir Plates
e. Removal and Replacement of Aerobic Digester Blowers
f. Removal and Replacement of Aerobic Digester Diffusers
g. Chlorine Contact Chamber Concrete Repair and Coating
h. Concrete Repair and Coating of Clarifier Effluent Trough
i. Provision and Installation of New Sodium Hypochlorite Dilution and Feed System
j. Electrical Work and Controls.

B. Type of Contract:

1. Project will be constructed as a design-bid-build (DBB) contract.

1.4 WORK SEQUENCE

A. Contractor shall arrange the Work so that at no time shall it cause unnecessary interruption to the operation of existing facilities. Contractor shall prepare and submit to Engineer for approval, a complete detailed working schedule setting forth the sequence of operations the Contractor proposes to follow.

B. Before commencing Work of each phase, submit an updated copy of Contractor's construction schedule showing the sequence, commencement and completion dates, and move -in dates of Owner's personnel for Startup.

1.5 CONTRACTOR-FURNISHED AND INSTALLED PRODUCTS

A. Contractor shall furnish all products indicated in the bid documents. The Work includes unloading, handling, storing, and protecting Contractor-furnished products as directed and turning them over to Owner at Project closeout.

1.6 WORK BY OWNER

A. General: Cooperate fully with Owner so that work may be carried out smoothly, without interfering with or delaying work under this Contract or work by Owner. Coordinate the Work of this Contract with work performed by Owner.

1.7 ACCESS TO SITE

A. General: Contractor shall have full use of Project site for construction operations during construction period. Contractor's use of Project site is limited only by Owner's right to perform work or to retain other Contractors on portions of Project.

B. Use of Site: Limit use of Project site to areas within the Contract limits indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.

1. Driveways, Walkways and Entrances: Keep driveways, loading areas, and entrances clear and available to the Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or storing materials.

a. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.

1.8 COORDINATION WITH OCCUPANTS

A. Limited Owner Occupancy of Completed Areas of Construction: Owner reserves the right to occupy and to place/install equipment in completed areas of the Work, prior to Substantial Completion of the Work, provided such occupancy does not interfere with completion of the Work. Such placement of equipment and limited occupancy shall not constitute acceptance of the total Work.

1. Engineer will prepare a Certificate of Substantial Completion for each specific phase of the project.
2. Before limited Owner occupancy, mechanical and electrical systems shall be fully operational, and required tests and inspections shall be successfully completed. Upon occupancy, Owner will operate and maintain mechanical and electrical systems serving occupied portions of Work.

1.9 WORK RESTRICTIONS

A. General: Comply with restrictions on construction operations.

1. Comply with limitations on use of public streets and with other requirements of authorities having jurisdiction.

B. On-Site Work Hours: Working hours shall be coordinated with the Owner. Contractor shall contact the Engineer/Owner when working hours are extended beyond normal business hours or when weekend construction is expected to occur.

C. Noise, Vibration, and Odors: Coordinate operations that may result in high levels of noise and vibration, odors, or other disruption to neighbors with the Owner.

1. Obtain written permission from the Engineer before proceeding with disruptive operations.

D. Employee Screening: Comply with Owner's requirements for drug and background screening of Contractor personnel working on Project site.

1.10 ADVERSE WEATHER

A. General

1. Notice of rain delay days with the documentation of the aforementioned sources herein and on-site records must be submitted by the Contractor to the Inspector/Engineer on the first working day of every month for the previous month or at the monthly construction meeting as determined at the preconstruction meeting.

B. Definition

1. Adverse weather is defined as the occurrence of a condition that prevents construction activity exposed to weather conditions or access to the site for more than four (4) hours in a day.
2. Adverse weather may also include, if appropriate, “dry-out” or “mud” days.
3. Adverse weather includes days that temperature does not rise above the required temperature for a construction activity.

C. Qualifications

1. Adverse weather conditions having a direct effect on construction progress are to be handled as follows:

a. Precipitation is to be measured by the Contractor using a precipitation gauge on-site. For each month, the number of days (24 hours) that the site experiences precipitation of 0.10 inches or more shall be totaled, confirmed with the Owner/Inspector, and reported to the Engineer.

b. For each month, the total number of days of 0.10 inches or more of precipitation shall be compared to the number of expected days for that month. The number of expected days with precipitation of 0.10 inches or more shall be established as follows:

1) Identify National Oceanic and Atmospheric (NOAA) weather stations as shown at https://www.ncdc.noaa.gov/cdo-web/search within a 100-mile radius of the project location.

a) If multiple weather stations are found within 100 miles of the project site, the weather station that is the closest to the site shall be used. Compile rain data from the previous 5 years and total the number of days with precipitation of 0.10 inches or more.

b) If a weather station is not found within a 100-mile radius of the site, the following schedule shall be used:

Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
7	6	7	6	5	6	8	6	5	4	4	8
(Data from NOAA, > 0.10” Daily Precipitation, January 2007 – May 2022, Montgomery, AL)											

c. Rain delay days will be approved by the Engineer and added to the contract duration only if they exceed the number of expected days for that given month.

2. Adverse weather conditions having an indirect effect due to precipitation are to be handled as follows:

    a. Precipitation that occurs beyond the standard baseline which results in "dry-out" or "mud" days.

        1) The standard baseline is based on the NOAA's Point Precipitation Frequency (PPF) Estimate for the construction area using the latitude and longitude for a 1-year average recurrence interval and a 60-min time period. This can be found at PF Data Server-PFDS/HDSC/OWP (noaa.gov).

            a) Select the desired state from the dropdown arrow or click on the map.
            b) Insert the latitude and longitude, address, or select the station that is associated with the project.
            c) Use the table generated below the map to identify the standard baseline.

3. Adverse weather conditions due to temperature are as follows:

        1) Cold Weather concreting shall be per ACI 306.

            a) The Contractor shall have a calibrated thermometer onsite, which is logged by the Inspector and Contractor prior to any concrete pours during cold weather.

4. Adverse weather conditions due to wind speeds are as follows:

    a. Wind speeds exceeding those permissible to use equipment or to perform certain tasks safely, including but not limited to operating crane(s) or other aerial equipment for construction or erection of a building structure.

        1) The Contractor shall have a calibrated wind speed gauge on-site.

5. Adverse weather conditions resulting in compromised project site conditions are as follows:

    a. Project site conditions such as mud, pooling of water, ice, or standing snow subsequent to the actual precipitation days, that prevents the performance of activities such as, but not limited to, mass grading, building pad grading, foundations, piping, excavations, backfill, concrete, masonry, etc. operations.

D. Weather Delay Days

1. Adverse weather delay days may be counted if adverse weather prevents work on the project during an event where:

    a. Precipitation days for a specific month is greater than the recorded monthly average for a project location indicated above.

        1) The number of average rain days shall be subtracted from the number of recorded rain days and the difference shall be the allotted time.

b. Precipitation for a given day is greater than the NOAA's PFF estimate indicated above.

1) One (1) day for each day or consecutive days of precipitation that exceeds the standard baseline.

c. Precipitation of 3.0 inches over a 24-hour period.

1) The number of allotted days shall be at the discretion of the Engineer/Owner based on site conditions, working conditions, and type of construction.
2) Temperature per ACI 306.

E. Exceptions

1. The Contractor shall take into account that certain construction activities are more affected by adverse weather and seasonal conditions than other activities, and that "dry-out" or "mud" days are not eligible to be counted as an Adverse Weather Delay Day until the standard baseline is exceeded. Hence, the Contractor should allow for an appropriate number of additional days associated with the Standard Baseline days in which such applicable construction activities are expected to be prevented and suspended.

F. Record Keeping

1. All Adverse Weather events shall be recorded by the on-site management team.
2. On-site records of daily rain and/or temperature readings shall be kept by the Contractor and may be accepted to verify weather and/or temperature variations which prevent earthwork, foundation and slabs, and/or roofing materials installation. The Inspector shall also be required to maintain on-site records of daily rain and/or temperature.

1.11 SPECIFICATION AND DRAWING CONVENTIONS

A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations.

1. Specification requirements are to be performed by Contractor, unless specifically stated otherwise.

B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.

C. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:

1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
2. Abbreviations: Materials and products are identified by abbreviations.

1.12 WARRANTIES

A. Warranties shall conform to the requirements of the General Conditions.

B. All equipment supplied by the Contractor under these Specifications shall be warranted by the Contractor and the equipment manufacturers for a period of one (1) year. Warranty period shall commence on the date of Substantial Completion.

C. The equipment shall be warranted to be free from defects in workmanship, design and materials. If any part of the equipment should fail due to workmanship, design and materials during the warranty period, it shall be replaced by the Contractor and the unit(s) restored to service at no expense to the Owner.

D. The manufacturer's warranty period shall run concurrently with the Contractor's warranty or guarantee period. No exception to this provision shall be allowed. The Contractor shall be responsible for obtaining equipment warranties from each of the respective suppliers or manufacturers for all the equipment specified.

1.13 CONSTRUCTION SEQUENCE

A. Construction of the WWTP Improvements shall be performed to the fullest extent possible without interrupting the operations of the plant. Adequate wastewater treatment shall occur at all times. All shutdowns and bypasses shall be coordinated with the Owner and Operator.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 10 00

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 01 21 00 - ALLOWANCES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes administrative and procedural requirements governing allowances.

1. Certain items are specified in the Contract Documents by allowances. Allowances have been established in lieu of additional requirements and to defer selection of actual materials and equipment to a later date when additional information is available for evaluation. If necessary, additional requirements will be issued by Change Order.

B. Types of allowances include the following:

1. Lump-sum allowances.
2. Testing and inspecting allowances.
3. Contingency allowances.

1.2 RELATED DOCUMENTS

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

B. Related work specified elsewhere includes:

1. Divisions 2 through 50.

1.3 SELECTION AND PURCHASE

A. At the earliest practical date after award of the Contract, advise Engineer of the date when final selection and purchase of each product or system described by an allowance must be completed to avoid delaying the Work.

B. At Engineer’s request, obtain proposals for each allowance for use in making final selections. Include recommendations that are relevant to performing the Work.

C. Purchase products and systems selected by Engineer from the designated supplier.

1.4 SUBMITTALS

A. Submit proposals for purchase of products or systems included in allowances, in the form specified by Engineer.

B. Submit invoices or delivery slips to show actual quantities of materials delivered to the site for use in fulfillment of each allowance.

C. Coordinate and process submittals for allowance items in same manner as for other portions of the Work.

1.5 COORDINATION

A. Coordinate allowance items with other portions of the Work. Furnish templates as required to coordinate installation.

1.6 ALLOWANCES

A. Lump Sum

1. Allowance shall include cost to Contractor of specific products and materials ordered by Owner under allowance and shall include taxes, freight, and delivery to Project site.
2. Contractor's costs for receiving and handling at Project site, labor, installation, overhead and profit, and similar costs related to products and materials ordered by Owner under allowance shall be included as part of the Contract Sum and not part of the allowance.
3. At Project closeout, credit unused amounts remaining in these allowances to Owner by Change Order.

B. Testing and Inspection

1. Testing and inspecting allowances include the cost of engaging testing agencies, actual tests and inspections, and reporting results.
2. The allowance does not include incidental labor required to assist the testing agency or costs for retesting if previous tests and inspections result in failure. The cost for incidental labor to assist the testing agency shall be included in the Contract Sum.
3. Costs of services not required by the Contract Documents are not included in the allowance.
4. At Project closeout, credit unused amounts remaining in the testing and inspecting allowance to Owner by Change Order.

C. Quantity

1. Allowance shall include cost to Contractor of specific products and materials ordered by Owner or selected by Engineer under allowance and shall include taxes, freight**,** and delivery to Project site.
2. Unless otherwise indicated, Contractor's costs for receiving and handling at Project site, labor, installation, overhead and profit, and similar costs related to products and materials ordered by Owner or selected by Engineer under allowance shall be included as part of the Contract Sum and not part of the allowance.
3. Unused Materials: Return unused materials purchased under an allowance to manufacturer or supplier for credit to Owner, after installation has been completed and accepted.
    a. If requested by Engineer, retain and prepare unused material for storage by Owner. Deliver unused material to Owner's storage space as directed.

D. Contingency

1. Use the contingency allowance only as directed by Engineer for Owner's purposes and only by Change Orders that indicate amounts to be charged to the allowance.
2. Contractor's overhead, profit, and related costs for products and equipment ordered by Owner under the contingency allowance are included in the allowance and are not part of the Contract Sum. These costs include delivery, installation, taxes, insurance, equipment rental, and similar costs.
3. Change Orders authorizing use of funds from the contingency allowance will include Contractor's related costs and reasonable overhead and profit.
4. At Project closeout, credit unused amounts remaining in the contingency allowance to Owner by Change Order.

1.7 UNUSED MATERIALS

A. Return unused materials purchased under an allowance to manufacturer or supplier for credit to Owner, after installation has been completed and accepted.

1. If requested by Engineer, prepare unused material for storage by Owner when it is not economically practical to return the material for credit. If directed by Engineer, deliver unused material to Owner's storage space. Otherwise, disposal of unused material is Contractor's responsibility.

1.8 ADJUSTMENT OF ALLOWANCES

A. Allowance Adjustment: To adjust allowance amounts, prepare a Change Order proposal based on the difference between purchase amount and the allowance, multiplied by final measurement of work-in-place where applicable. If applicable, include reasonable allowances for cutting losses, tolerances, mixing wastes, normal product imperfections, required maintenance materials, and similar margins.

1. Include installation costs in purchase amount only where indicated as part of the allowance.
2. If requested, prepare explanation and documentation to substantiate distribution of overhead costs and other markups.
3. Submit substantiation of a change in scope of Work, if any, claimed in Change Orders related to unit-cost allowances.
4. Owner reserves the right to establish the quantity of work-in-place by independent quantity survey, measure, or count.

B. Submit claims for increased costs due to a change in the scope or nature of the allowance described in the Contract Documents, whether for the purchase order amount or Contractor's handling, labor, installation, overhead, and profit.

1. Do not include Contractor's or subcontractor's indirect expense in the Change Order cost amount unless it is clearly shown that the nature or extent of Work has changed from what could have been foreseen from information in the Contract Documents.
2. No change to Contractor's indirect expense is permitted for selection of higher- or lower-priced materials or systems of the same scope and nature as originally indicated.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine products covered by an allowance promptly on delivery for damage or defects. Return damaged or defective products to manufacturer for replacement.

3.2 PREPARATION

A. Coordinate materials and their installation for each allowance with related materials and installations to ensure that each allowance item is completely integrated and interfaced with related work.

3.3 SCHEDULE OF ALLOWANCES

A. The following allowances shall be included in Contract Sum in accordance with the allowance type described above. Should the below allowances not be shown on the project proposal, the Contractor shall include them in the total bid cost.

1. Allowance No. 1: Lump Sum Allowance: Include the sum of $15,000 for Engineering Startup

    a. Startup/commissioning is a systematic process of ensuring that all systems perform interactively according to the design intent and the Owner's operational needs. The startup and commissioning process shall verify that applicable equipment and systems are installed according to the manufacturer's recommendations and to industry accepted minimum standards and that they receive adequate operational checkout by installing contractors. The objective of functional performance testing is to demonstrate that each system is operating according to the Contract Documents. Functional testing facilitates bringing the systems from a state of substantial completion to full operation. The testing process shall identify areas of deficient performance and these areas shall be corrected, improving the operation and functioning of the systems. The allowance set forth herein shall include assistance with engineering startup and commissioning activities to ensure areas of deficient performed are operation and functioning as designed and intended.

2. Allowance No. 2: Lump Sum Allowance: Include the sum of $60,000 for Owner's Contingency

    a. This allowance may be used, as authorized and directed by the Engineer, to pay for costs of additional work resulting from the need to address minor items at any of the facilities in which work is being performed and throughout the plant. Cost amounts shall be determined as specified in the General Conditions for Lump Sum changes or Time and Expense changes. This work is not shown or specified in the drawings and specifications bid by the Contractor and not covered by another line

item in the bid. This work may be required in the event the Engineer or Owner established the need for additional work deemed to be necessary for the successful completion of the contract. This cash allowance is to be included in the Lump Sum Base Bid, but is to be paid to the Contractor only if authorized as provided in this paragraph.

END OF SECTION 01 21 00

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 01 25 00 - SUBSTITUTION OF MAJOR EQUIPMENT ITEMS & PRODUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 GENERAL REQUIREMENTS

A. This section of the specifications defines the LUMP SUM TOTAL BID PRICE contract format using "Basis of Bid" major equipment items, materials, and products for preparation of the TOTAL BID PRICE and outlines the procedure for proposal of substitute items by "alternate" manufacturers. The use of this bidding format is intended to provide a common basis for all bidders on which to base their LUMP SUM TOTAL BID PRICE. This bidding format also protects the Owner and bidders so that no one bidder gains an unfair bid price advantage by quoting a lower price for a major equipment item or product which is not "or approved equal". This format is intended to assure that the Owner receives full benefit of the savings in cost involved in any substitution of a major equipment item or product.

B. The proposal for the bid is based on a total bid price contract using "Basis of Bid" major equipment items and products which have been identified and described in the specifications. Manufacturers of major equipment items and products identified in "Manufacturer" column in the proposal are considered "Basis of Bid" items. Specification sections defining "Basis of Bid" major equipment items or products include the following:

1.	Section 43 11 33	Rotary Screw Blowers
2.	Section 43 22 10	Open Flight Archimedes Screw Pumps
3.	Section 43 22 15	Tube Mounted Archimedes Screw Pumps
4.	Section 43 41 45	Vertical Polyethylene Tanks and Accessories
5.	Section 46 21 15	Mechanical Screen & Compacting Equipment
6.	Section 46 33 41	Liquid Chemical Feed Systems
7.	Section 46 33 66	Liquid Chemical Transfer Pumps
8.	Section 46 51 46	Fine Bubble Diffusers

C. The TOTAL BID PRICE noted in the proposal shall include the installed prices of only "Basis of Bid" major equipment items or products. The bidder shall note the installed price of each "Basis of Bid" major equipment item or product in the space provided in the "Total Price" column in the proposal. The installed price shall include the labor and material cost, profit and overhead, plus the cost for all necessary appurtenances to provide a complete system. The installed price is for the equipment and installation and does not include associated structures, pipe, valves, etc.

D. Pursuant to Federal Regulations 40 CFR, Parts 33 and 35, it is not the intent of the Contract Documents to contain proprietary, exclusionary, of discriminatory requirements other than those based on performance. Manufacturers who believe that their equipment can meet the

performance requirements and, with the exception of minor details, the technical requirements of the Contract Documents, are encouraged to submit a quotation to a Bidder for a substitute major equipment item or product. Model number designations for the major equipment items are included for information purposes. Proposed "Basis of Bid" major equipment items and "Alternate" major equipment items will be evaluated on the basis of the requirements contained in the contract documents.

E. Bidder's desiring to quote a price for a substitute major equipment item or product in lieu of a "Basis of Bid" item shall submit **14 days prior to the Bid Date** a "Qualification Package" for each "Alternate" major equipment item or product which the Bidder proposes to furnish in lieu of a "Basis of Bid" major equipment item or product identified in the "Manufacturer" column. The bidder shall submit each Qualification Package under separate cover. Each Qualification Package shall be bound with protective cover, identify the specification section number and title, and the product manufacturer's name on a cover sheet.

F. The "Qualification Package" for the "Alternate" major equipment items shall include but not be limited to the following information:

1. A complete set of drawings, specifications, catalog cut sheets of the proposed major equipment items or products, to identify all technical and performance requirements as contained in the drawings and specifications.
2. Detailed information shall be submitted for all buy-out items such as hardware, motors, motor controllers and instrumentation (field device, major control panel device, and anticipated control panel layout).
3. List showing materials of construction of all components, including all buy-out items.
4. List manufacturer's recommended spare parts, including all buy-out items.
5. Information on equipment field erection requirements including total weight of assembled components and weight of each sub assembly.
6. Process equipment electrical requirements and schematic diagrams. Examples of reports and hard copies of CRT displays similar to those required by the project.
7. Detailed written documentation with discussion of all durations of equipment, including all buy-out items, from the Contract Documents.

G. If the Bidder fails to furnish all the preceding information which has been deemed necessary by the Engineer to evaluate a proposed "Alternate" major equipment item or product for equivalency with the "Basis of Bid" major equipment item or product, the proposed "Alternate" qualification package may be rejected by the Engineer. If the "Alternate" qualification package is rejected by the Engineer, the Bidder shall furnish the "Basis of Bid" major equipment item or product for the installed price noted in "TOTAL PRICE" Column of the Bid Proposal Form.

H. No proposal "Alternate" major equipment item or product will be considered unless, in the opinion of the Engineer, it conforms to the Contract Documents in all respects, except for make and manufacturer and minor details.

I. The Engineer shall be the sole authority for determining conformance of a proposed "Alternate" major equipment item or product with the Contract Documents. Under no circumstances will the Engineer be required to prove that an "Alternate" major equipment item or product is not equal to the "Base of Bid" major equipment item or product.

J. Award of the Contract will be made on the basis of the Bid Proposal Form from the lowest responsive, responsible, qualified Bidder using the TOTAL BASE BID PRICE plus additive bid items.

K. Acceptance of a proposed "Alternate" major equipment item or product "Qualification Package", or naming of "Basis of Bid" equipment, does not eliminate the need for shop drawing submittals and reviews during construction, nor does it eliminate the requirements that the equipment manufacturer satisfy the requirements of the Contract Documents.

L. Should the Bidder furnish a major equipment item or product requiring changes to the Contract Documents, he shall notify the Engineer in writing of all dimensional, mechanical, electrical and structural changes and/or requirements for the major equipment item's use in this Project and shall reimburse the Owner for any associated redesign and/or construction drawings. The Bidder shall consider all costs associated in furnishing and installing a major equipment item or product in his installed price proposal. Redesign and contract drawing revisions to accommodate equipment or products will be prepared by the Engineer during the shop drawing review process. Reimbursement shall be based on 2.5 times the Engineer's salary cost plus reimbursement expenses at cost.

M. The bidder shall <u>not</u> use the installed price for any proposed "Alternate" major equipment item or product in preparing the TOTAL BID PRICE unless approved by ENGINEER through an addendum.

N. An electronic submittal will not be accepted unless it is submitted formally with a single PDF divided appropriately to identify the above referenced requirements. Manufacturer's standard sales literature is not acceptable for submission and will be rejected, as well as unorganized submissions with multiple attachments.

O. If a discrepancy appears between the written and the numerical, the written words will be used as the quoted price. If an error appears in an extension or the addition of items, the corrected extension or total of the parts shall govern.

P. It is understood and agreed that a Bid Proposal Form cannot be withdrawn within ninety (90) days without the consent of the City, Board, or Authority of which the bid documents herein are prepared and that the said City, Board or Authority of has the right to accept or reject any or all Bid Proposal Forms and to waive any irregularities and informalities.

PART 2 - PRODUCTS - Not Used

PART 3 - EXECUTION - Not Used

END OF SECTION 01 25 00

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 01 26 00 - CONTRACT MODIFICATION PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for handling and processing Contract modifications.

B. Related Requirements:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 MINOR CHANGES IN THE WORK

A. Engineer will issue supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time.

1.3 PROPOSAL REQUESTS

A. Owner-Initiated Proposal Requests: Engineer will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.

1. Work Change Proposal Requests issued by Engineer are not instructions either to stop work in progress or to execute the proposed change.
2. Within 10 days after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.

    a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
    b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
    c. Include costs of labor and supervision directly attributable to the change.
    d. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
    e. Quotation Form: Use forms acceptable to Engineer.

B. Contractor-Initiated Proposals: If latent or changed conditions require modifications to the Contract, Contractor may initiate a claim by submitting a request for a change to Engineer.

1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.
2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
4. Include costs of labor and supervision directly attributable to the change.
5. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
6. Proposal Request Form: Use form acceptable to the Engineer.

1.4 CHANGE ORDER PROCEDURES

A. Change Order Procedures shall conform to the requirements of the General Conditions.

B. A change in the project work that is consistent with the objective of the project and outside the scope of the project requires the execution and approval of a Change Order.

C. On Owner's approval of a Work Changes Proposal Request, Engineer will issue a Change Order for signatures of Owner and Contractor on form included in the bid documents.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 26 00

SECTION 01 29 00 - PAYMENT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements necessary to prepare and process Applications for Payment.

B. Related Requirements:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
2. Section 01 26 00 - Contract Modification Procedures for administrative procedures for handling changes to the Contract.
3. Section 01 32 00 - Construction Progress Documentation for administrative requirements governing the preparation and submittal of the Contractor's construction schedule.

1.2 DEFINITIONS

A. Schedule of Values: A statement furnished by Contractor allocating portions of the Contract Sum to various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.

1.3 SCHEDULE OF VALUES

A. Coordination: Coordinate preparation of the schedule of values with preparation of Contractor's construction schedule.

1. Coordinate line items in the schedule of values with other required administrative forms and schedules, including the following:

    a. Application for Payment forms with continuation sheets.
    b. Submittal schedule.
    c. Items required to be indicated as separate activities in Contractor's construction schedule.

2. Submit the schedule of values to Engineer at earliest possible date, but no later than 14 days before the date scheduled for submittal of initial Applications for Payment.
3. Subschedules for Phased Work: Where the Work is separated into phases requiring separately phased payments, provide subschedules showing values coordinated with each phase of payment.
4. Subschedules for Separate Elements of Work: Where the Contractor's construction schedule defines separate elements of the Work, provide subschedules showing values coordinated with each element.

B. Format and Content: Use Project Manual table of contents as a guide to establish line items for the schedule of values. Provide at least one line item for each Specification Section where a submittal is required.

1. Identification: Include the following Project identification on the schedule of values:

    a. Project name and location.
    b. Name of Engineer.
    c. Engineer's project number.
    d. Contractor's name and address.
    e. Date of submittal.

2. Arrange schedule of values consistent with format of Contract Documents used (EJCDC, AIA, etc.).
3. Arrange the schedule of values in tabular form with separate columns to indicate the following for each item listed:

    a. Related Specification Section or Division.
    b. Description of the Work.
    c. Name of subcontractor.
    d. Name of manufacturer or fabricator.
    e. Name of supplier.
    f. Change Orders (numbers) that affect value.
    g. Dollar value of the following, as a percentage of the Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent.

        1) Labor.
        2) Materials.
        3) Equipment.

4. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with Project Manual table of contents. Provide multiple line items for principal subcontract amounts in excess of five percent of the Contract Sum.

    a. Include separate line items under contractor and principal subcontracts for Project closeout requirements in an amount totaling no less than 2.5% of the Contract Sum and subcontract amount.

5. Round amounts to nearest whole dollar; total shall equal the Contract Sum.
6. Provide a separate line item in the schedule of values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.

    a. Differentiate between items stored on-site and items stored off-site. If required, include evidence of insurance.

7. Provide separate line items in the schedule of values for initial cost of materials, for each subsequent stage of completion, and for total installed value of that part of the Work.
8. Allowances: Provide a separate line item in the schedule of values for each allowance. Show line-item value of unit-cost allowances, as a product of the unit cost, multiplied by

measured quantity. Use information indicated in the Contract Documents to determine quantities.

9. Each item in the schedule of values and Applications for Payment shall be complete. Include total cost and proportionate share of general overhead and profit for each item.

    a. Temporary facilities and other major cost items that are not direct cost of actual work-in-place may be shown either as separate line items in the schedule of values or distributed as general overhead expense, at Contractor's option.

10. Schedule Updating: Update and resubmit the schedule of values before the next Applications for Payment when Change Orders or Construction Change Directives result in a change in the Contract Sum.

1.4 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments as certified by engineer and contractor and paid for by Owner.

    1. Initial Application for Payment, Application for Payment at time of Substantial Completion, and final Application for Payment involve additional requirements.

B. Payment Application Times: Submit Application for Payment to Engineer by the 25th day of the month. The period covered by each Application for Payment is one month, ending on the last day of the month.

    1. Submit draft copy of Application for Payment five days prior to due date for review by Engineer.

C. Application for Payment Forms: Use form consistent with Contract Documents (EJCDC, AIA, etc.) for Applications for Payment.

    1. Other Application for Payment forms proposed by the Contractor may be acceptable to Engineer and Owner. Submit forms for approval with initial submittal of schedule of values.

D. Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor.

    1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
    2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
    3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.

E. Stored Materials: Include in Application for Payment amounts applied for materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.

1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
3. Provide summary documentation for stored materials indicating the following:

    a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
    b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
    c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.

F. Transmittal:

1. Deliverable:

    a. Hard Copy: Submit one (1) signed and notarized original copy of each Application for Payment to Engineer by a method ensuring receipt within 24 hours. One copy shall include waivers of lien and similar attachments if required.
    b. Digital: Submit one (1) signed and notarized copy of each Application for Payment to Engineer by a method ensuring receipt within 24 hours. One copy shall include waivers of lien and similar attachments if required.

2. Contractor’s Affidavit of Payment to Subcontractors

    a. Shall be submitted with each Application for Payment.

3. Contractor Progress Lien Waivers – Specification Section 01 29 00 A

    a. Shall be submitted with each Application for Payment after No. 1.

4. Subcontractor/Supplier Lien Waivers – Specification Section 01 29 00 B

    a. Shall be submitted with each Application for Payment after No. 1.

5. Transmit each copy with a transmittal form listing attachments and recording appropriate information about application.

G. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:

1. List of subcontractors.
2. Schedule of values.
3. Contractor's construction schedule (preliminary if not final).
4. Products list (preliminary if not final).
5. List of Contractor's staff assignments.
6. Copies of building and other local/state permits.
7. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.

8. Report of preconstruction conference.
9. Certificates of insurance and insurance policies.
10. Performance and payment bonds.
11. Data needed to acquire Owner's insurance.

H. Application for Payment at Substantial Completion: After Engineer issues the Certificate of Substantial Completion, submit an Application for Payment showing 100 percent completion for portion of the Work claimed as substantially complete.

1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
2. This application shall reflect Certificate(s) of Substantial Completion issued previously for Owner occupancy of designated portions of the Work.

I. Final Payment Application: After completing Project closeout requirements, submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:

1. Evidence of completion of Project closeout requirements.
2. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
3. Updated final statement, accounting for final changes to the Contract Sum.
4. "Contractor's Affidavit of Payment of Debts and Claims."
5. "Contractor's Affidavit of Release of Liens."
6. "Consent of Surety to Final Payment."
7. Evidence that claims have been settled.
8. Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Substantial Completion or when Owner took possession of and assumed responsibility for corresponding elements of the Work.
9. Final liquidated damages settlement statement.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 29 00

THIS PAGE INTENTIONALLY LEFT BLANK

CONTRACTOR'S UNCONDITIONAL LIEN WAIVER UPON PROGRESS PAYMENT

The undersigned hereby acknowledge that the amount of

_____

was received from

_____

The Owner

as Progress Payment for the following goods and/or services:

_____

_____

_____

performed at the property described as:

_____

_____

_____

The undersigned hereby waives the right to assert a lien and release any lien against the owner to this extent only. This lien waiver does not affect the right of the undersigned to recover payment for any other goods or services supplied before or after this release date not compensated by the progress payment or any rights which the undersigned may have by contract.

_____

Title and Name of Claimant

_____

_____

_____

Company Details

_____

Signature

_____

Date

SUBCONTRACTOR'S UNCONDITIONAL LIEN WAIVER UPON PROGRESS PAYMENT

The undersigned hereby acknowledges that the amount of

_____

was received from

_____

as Progress Payment for the following goods and/or services:

_____

for the following project:

_____

(Project Name)

_____

(Owner)

performed at the property described as:

_____

_____

through the following date:

_____

The undersigned hereby waives the right to assert a lien and release any lien against the owner to this extent only. This lien waiver does not affect the right of the undersigned to recover payment for any other goods or services supplied before or after this release date not compensated by the progress payment or any rights which the undersigned may have by contract.

_____

Title and Name of Claimant

_____

(Company Name)

_____

(Address)

_____

Signature

_____

Date

SECTION 01 31 00 - PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 SUMMARY

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

1. General coordination procedures.
2. Coordination drawings.
3. Requests for Information (RFIs).
4. Project Web site.
5. Project meetings.

B. Each contractor shall participate in coordination requirements.

C. Related Requirements:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
2. Section 01 32 00 - Construction Progress Documentation, for preparing and submitting Contractor's construction schedule.

1.2 DEFINITIONS

A. RFI: Request from Engineer seeking information required by or clarifications of the Contract Documents.

1.3 INFORMATIONAL SUBMITTALS

A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:

1. Name, address, and telephone number of entity performing subcontract or supplying products.
2. Number and title of related Specification Section(s) covered by subcontract.
3. Drawing number and detail references, as appropriate, covered by subcontract.

B. Key Personnel Names: No less than 15 days prior to starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home, office, and cellular telephone numbers and e-mail addresses. Provide names, addresses, and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to Project.

1. Post copies of list in project meeting room, in temporary field office and at existing treatment facility. Keep list current at all times.

1.4 GENERAL COORDINATION PROCEDURES

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

1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
3. Make adequate provisions to accommodate items scheduled for later installation.

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

1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.

C. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.

1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. See other Sections for disposition of salvaged materials that are designated as Owner's property.

1.5 REQUESTS FOR INFORMATION (RFIs)

A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.

1. Engineer will return RFIs submitted to Engineer by other entities controlled by Contractor with no response.
2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.

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

1. Project name.
2. Project number.
3. Date.
4. Name of Contractor.

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

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

C. RFI Forms: As acceptable to the Engineer.

1. Attachments shall be electronic files in PDF format.

D. Engineer Action: Engineer will review each RFI, determine action required, and respond. Allow seven (7) working days for Engineer’s response for each RFI. RFIs received by Engineer after 1:00 p.m. will be considered as received the following working day.

1. The following Contractor-generated RFIs will be returned without action:

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

2. Engineer's action may include a request for additional information, in which case Engineer's time for response will date from time of receipt of additional information.
3. Engineer's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Section 01 26 00 - Contract Modification Procedures.

    a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Engineer in writing within five days of receipt of the RFI response.

E. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log monthly. Include the following:

1. Project name.
2. Name and address of Contractor.
3. Name and address of Engineer

4. RFI number including RFIs that were returned without action or withdrawn.
5. RFI description.
6. Date the RFI was submitted.
7. Date Engineer's response was received.

F. On receipt of Engineer's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Engineer within five (5) days if Contractor disagrees with response.

1. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.
2. Identification of related Field Order, Work Change Directive, and Proposal Request, as appropriate.

1.6 PROJECT MEETINGS

A. General: Schedule and conduct meetings and conferences at Project site unless otherwise indicated.

1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Engineer of scheduled meeting dates and times.
2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Engineer, within seven days of the meeting.

B. Preconstruction Conference: Engineer will schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner and Engineer, but no later than 15 days before mobilization.

1. Conduct the conference to review responsibilities and personnel assignments.
2. Attendees: Authorized representatives of Owner, Engineer, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
3. Agenda: Discuss items of significance that could affect progress, including the following:

    a. Tentative construction schedule.
    b. Phasing.
    c. Critical work sequencing and long-lead items.
    d. Designation of key personnel and their duties.
    e. Lines of communications.
    f. Procedures for processing field decisions and Change Orders.
    g. Procedures for RFIs.
    h. Procedures for testing and inspecting.
    i. Procedures for processing Applications for Payment.
    j. Distribution of the Contract Documents.
    k. Submittal procedures.
    l. Preparation of record documents.

m. Use of the premises.
n. Work restrictions.
o. Working hours.
p. Owner's occupancy requirements.
q. Responsibility for temporary facilities and controls.
r. Procedures for moisture and mold control.
s. Procedures for disruptions and shutdowns.
t. Construction waste management and recycling.
u. Parking availability.
v. Office, work, and storage areas.
w. Equipment deliveries and priorities.
x. First aid.
y. Security.
z. Progress cleaning.

4. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.

C. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity that requires coordination with other construction.

1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Engineer and Owner of scheduled meeting dates.
2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:

a. Contract Documents.
b. Options.
c. Related RFIs.
d. Related Change Orders.
e. Purchases.
f. Deliveries.
g. Submittals.
h. Review of mockups.
i. Possible conflicts.
j. Compatibility requirements.
k. Time schedules.
l. Weather limitations.
m. Manufacturer's written instructions.
n. Warranty requirements.
o. Compatibility of materials.
p. Acceptability of substrates.
q. Temporary facilities and controls.
r. Space and access limitations.
s. Regulations of authorities having jurisdiction.
t. Testing and inspecting requirements.
u. Installation procedures.
v. Coordination with other work.
w. Required performance results.

x. Protection of adjacent work.
y. Protection of construction and personnel.

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

D. Project Closeout Conference: Schedule and conduct a project closeout conference, at a time convenient to Owner and Engineer, but no later than 90 days prior to the scheduled date of Substantial Completion.

1. Conduct the conference to review requirements and responsibilities related to Project closeout.
2. Attendees: Authorized representatives of Owner, Engineer, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
3. Agenda: Discuss items of significance that could affect or delay Project closeout, including the following:

a. Preparation of record documents.
b. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance.
c. Submittal of written warranties.
d. Requirements for preparing operations and maintenance data.
e. Requirements for delivery of material samples, attic stock, and spare parts.
f. Requirements for demonstration and training.
g. Preparation of Contractor's punch list.
h. Procedures for processing Applications for Payment at Substantial Completion and for final payment.
i. Submittal procedures.

4. Minutes: Entity conducting meeting will record and distribute meeting minutes.

E. Progress Meetings: Conduct progress meetings at minimum monthly intervals.

1. Coordinate dates of meetings with preparation of payment requests.
2. Attendees: In addition to representatives of Owner and Engineer, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
3. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.

a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.

1) Review schedule for next period.

b. Review present and future needs of each entity present, including the following:

1) Interface requirements.
2) Sequence of operations.
3) Status of submittals.
4) Deliveries.
5) Off-site fabrication.
6) Access.
7) Site utilization.
8) Temporary facilities and controls.
9) Progress cleaning.
10) Quality and work standards.
11) Status of correction of deficient items.
12) Field observations.
13) Status of RFIs.
14) Status of proposal requests.
15) Pending changes.
16) Status of Change Orders.
17) Pending claims and disputes.
18) Documentation of information for payment requests.

4. Minutes: Entity responsible for conducting the meeting will record and distribute the meeting minutes to each party present and to parties requiring information.

a. Schedule Updating: Revise Contractor's construction schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

F. Coordination Meetings: Conduct Project coordination meetings as necessary. Project coordination meetings are in addition to specific meetings held for other purposes, such as progress meetings and preinstallation conferences.

1. Attendees: In addition to representatives of Owner and Engineer, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meetings shall be familiar with Project and authorized to conclude matters relating to the Work.
2. Agenda: Review and correct or approve minutes of the previous coordination meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.

a. Combined Contractor's Construction Schedule: Review progress since the last coordination meeting. Determine whether each contract is on time, ahead of schedule, or behind schedule, in relation to combined Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.

b. Schedule Updating: Revise combined Contractor's construction schedule after each coordination meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with report of each meeting.

c. Review present and future needs of each contractor present, including the following:

1) Interface requirements.
2) Sequence of operations.
3) Status of submittals.
4) Deliveries.
5) Off-site fabrication.
6) Access.
7) Site utilization.
8) Temporary facilities and controls.
9) Work hours.
10) Hazards and risks.
11) Progress cleaning.
12) Quality and work standards.
13) Change Orders.

3. Reporting: Record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 31 00

SECTION 01 32 00 - CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:

1. Startup construction schedule.
2. Contractor's construction schedule.
3. Construction schedule updating reports.
4. Weekly construction reports.
5. Material location reports.
6. Site condition reports.
7. Special reports.

B. Related Requirements:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
2. Section 01 33 00 - Submittal Procedures, for submitting schedules and reports.
3. Section 01 40 00 - Quality Requirements, for submitting a schedule of tests and inspections.
4. Section 01 70 00 - Execution and Closeout Procedures, for submitting photographic documentation as project record documents at Project closeout.
5. Section 01 79 00 - Demonstration and Training, for submitting video recordings of demonstration of equipment and training of Owner's personnel.

1.2 INFORMATIONAL SUBMITTALS

A. Format for Submittals: Submit required submittals in the following format:

1. PDF electronic file.

B. Startup construction schedule.

C. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.

D. Construction Reports: Submit, at minimum, monthly intervals.

E. Material Location Reports: Submit at monthly intervals.

F. Site Condition Reports: Submit at time of discovery of differing conditions.

G. Special Reports: Submit at time of unusual event.

PART 2 - PRODUCTS

2.1 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

A. Time Frame: Extend schedule from date established for the Notice to Proceed to date of Substantial Completion.

1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.

B. Activities: Treat each process or separate area as a separate numbered activity for each main element of the Work. Comply with the following:

1. Procurement Activities: Include procurement process activities for the following long lead items and major items, requiring a cycle of more than sixty (60) days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
2. Submittal Review Time: Include review and resubmittal times indicated in Section 01 33 00 - Submittal Procedures in schedule. Coordinate submittal review times in Contractor's construction schedule with submittal schedule.
3. Startup and Testing Time: Include no fewer than thirty (30) days for startup and testing.
4. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Engineer's administrative procedures necessary for certification of Substantial Completion.
5. Punch List and Final Completion: Include not more than thirty (30) days for completion of punch list items and Final Completion.

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

1. Phasing: Arrange list of activities on schedule by phase.
2. Work Restrictions: Show the effect of the following items on the schedule:

a. Coordination with existing construction.
b. Limitations of continued occupancies.
c. Uninterruptible services.
d. Partial occupancy before Substantial Completion.
e. Use of premises restrictions.
f. Environmental control.

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

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

2.2 CONTRACTOR'S CONSTRUCTION SCHEDULE (GANTT CHART)

A. Gantt-Chart Schedule: Submit a comprehensive, fully developed, horizontal, Gantt-chart-type, Contractor's construction schedule within thirty (30) days of date established for the Notice to Proceed. Base schedule on the startup construction schedule and additional information received since the start of Project.

B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line.

1. For construction activities that require three months or longer to complete, indicate an estimated completion percentage in 10% percent increments within time bar.

2.3 REPORTS

A. Monthly Construction Reports: Prepare a Monthly construction report recording the following information concerning events at Project site:

1. List of subcontractors at Project site.
2. List of separate contractors at Project site.
3. Approximate count of personnel at Project site.
4. Equipment at Project site.
5. Material deliveries.
6. High and low temperatures and general weather conditions, including presence of rain or snow.
7. Accidents.
8. Meetings and significant decisions.
9. Unusual events (see special reports).
10. Stoppages, delays, shortages, and losses.
11. Emergency procedures.
12. Orders and requests of authorities having jurisdiction.
13. Change Orders received and implemented.
14. Work Directives received and implemented.
15. Services connected and disconnected.
16. Equipment or system tests and startups.
17. Partial completions and occupancies.
18. Substantial Completions authorized.

B. Material Location Reports: At monthly intervals, prepare and submit a comprehensive list of materials delivered to and stored at Project site. List shall be cumulative, showing materials previously reported plus items recently delivered. Include with list a statement of progress on and delivery dates for materials or items of equipment fabricated or stored away from Project site. Indicate the following categories for stored materials:

1. Material stored prior to previous report and remaining in storage.
2. Material stored prior to previous report and since removed from storage and installed.
3. Material stored following previous report and remaining in storage.

C. Site Condition Reports: Immediately on discovery of a difference between site conditions and the Contract Documents, prepare and submit a detailed report. Submit with a Request for

Information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

2.4 SPECIAL REPORTS

A. General: Submit special reports directly to Owner within two (2) day(s) of an occurrence. Distribute copies of report to parties affected by the occurrence.

B. Reporting Unusual Events: When an event of an unusual and significant nature occurs at Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, response by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise Owner in advance when these events are known or predictable.

PART 3 - EXECUTION

3.1 CONTRACTOR'S CONSTRUCTION SCHEDULE

A. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule two days before each regularly scheduled progress meeting.

1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
2. As the Work progresses, indicate final completion percentage for each activity.

B. Distribution: Distribute copies of approved schedule to Engineer, Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.

END OF SECTION 01 32 00

SECTION 01 33 00 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

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

B. Related Requirements:

1. Section 01 29 00 - Payment Procedures, for submitting Applications for Payment and the schedule of values.
2. Section 01 32 00 - Construction Progress Documentation, for submitting schedules and reports, including Contractor's construction schedule.
3. Section 01 78 23 - Operation and Maintenance Data, for submitting operation and maintenance manuals.
4. Section 01 78 39 - Project Record Documents, for submitting record Drawings, record Specifications, and record Product Data.
5. Section 01 79 00 - Demonstration and Training, for submitting video recordings of demonstration of equipment and training of Owner's personnel.

1.2 DEFINITIONS

A. Action Submittals: Written and graphic information and physical samples that require Engineer's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."

B. Informational Submittals: Written and graphic information and physical samples that do not require Engineer's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals."

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

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

1.3 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

A. Submittal Schedule: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making

corrections or revisions to submittals noted by Engineer and additional time for handling and reviewing submittals required by those corrections.

1. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Contractor's construction schedule.
2. Final Submittal: Submit concurrently with the first complete submittal of Contractor's construction schedule.

    a. Submit revised submittal schedule to reflect changes in current status and timing for submittals.

3. Format: Arrange the following information in a tabular format:

    a. Scheduled date for submittal.
    b. Specification Section number and title.
    c. Submittal category: Action; informational.
    d. Name of subcontractor.
    e. Description of the Work covered.
    f. Scheduled date for Engineer's final release or approval.
    g. Scheduled date of fabrication.

B. Engineer's Digital Data Files: Electronic digital data files of the Contract Drawings will be provided by Engineer for Contractor's use in preparing submittals.

1. Engineer will furnish Contractor one set of digital data drawing files of the Contract Drawings for use in preparing Shop Drawings and record documents.

    a. Engineer makes no representations as to the accuracy or completeness of digital data drawing files as they relate to the Contract Drawings.
    b. Digital Drawing Software Program: The Contract Drawings are available in Revit and CAD files.

C. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.

1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
4. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.

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

D. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Engineer’s receipt of submittal. No extension of the

Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.

1. Initial Review: Allow 14 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Engineer will advise Contractor when a submittal being processed must be delayed for coordination.
2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
3. Resubmittal Review: Allow 15 days for review of each resubmittal.
4. Sequential Review: Where sequential review of submittals by Engineer's consultants, Owner, or other parties is indicated, allow 21 days for initial review of each submittal.

E. Electronic Submittals: Identify and incorporate information in each electronic submittal file as follows:

1. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
2. Name file with submittal number or other unique identifier, including revision identifier.

    a. File name shall use project identifier and Specification Section number followed by a decimal point and then a sequential number (e.g., LNHS-061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., LNHS-061000.01.A).

3. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by Engineer.
4. Transmittal Form for Electronic Submittals: Use electronic form acceptable to Owner**,** containing the following information:

    a. Project name.
    b. Date.
    c. Name and address of Engineer.
    d. Name of Contractor.
    e. Name of firm or entity that prepared submittal.
    f. Names of subcontractor, manufacturer, and supplier.
    g. Category and type of submittal.
    h. Submittal purpose and description.
    i. Specification Section number and title.
    j. Specification paragraph number or drawing designation and generic name for each of multiple items.
    k. Drawing number and detail references, as appropriate.
    l. Location(s) where product is to be installed, as appropriate.
    m. Related physical samples submitted directly.
    n. Indication of full or partial submittal.
    o. Transmittal number.
    p. Submittal and transmittal distribution record.
    q. Other necessary identification.
    r. Remarks.

5. Metadata: Include the following information as keywords in the electronic submittal file metadata:

    a. Project name.
    b. Number and title of appropriate Specification Section.
    c. Manufacturer name.
    d. Product name.

F. Options: Identify options requiring selection by Engineer.

G. Deviations and Additional Information: On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Engineer on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same identification information as related submittal.

H. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.

1. Note date and content of previous submittal.
2. Note date and content of revision in label or title block and clearly indicate extent of revision.
3. Resubmit submittals until they are marked with approval notation from Engineer's action stamp.

I. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.

J. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Engineer's action stamp.

1.4 SUBMITTAL PROCEDURES

A. General Submittal Procedure Requirements: Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.

1. Submit electronic submittals via email as PDF electronic files.

    a. Engineer will return annotated file. Annotate and retain one copy of file as an electronic Project record document file.

2. Action Submittals: Submit one electronic copy of each submittal unless otherwise indicated. Engineer will not return copies.
3. Informational Submittals: Submit one electronic copy of each submittal unless otherwise indicated. Engineer will not return copies.
4. Certificates and Certifications Submittals: Provide a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.

a. Provide a digital signature with digital certificate on electronically submitted certificates and certifications where indicated.

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

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

a. Manufacturer's catalog cuts.
b. Manufacturer's product specifications.
c. Standard color charts.
d. Statement of compliance with specified referenced standards.
e. Testing by recognized testing agency.
f. Application of testing agency labels and seals.
g. Notation of coordination requirements.
h. Availability and delivery time information.

4. For equipment, include the following in addition to the above, as applicable:

a. Wiring diagrams showing factory-installed wiring.
b. Printed performance curves.
c. Operational range diagrams.
d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.

5. Submit Product Data before or concurrent with Samples.
6. Submit Product Data in the following format:

a. PDF electronic file.

C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data, unless submittal based on Engineer's digital data drawing files is otherwise permitted.

1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:

a. Identification of products.
b. Schedules.
c. Compliance with specified standards.
d. Notation of coordination requirements.
e. Notation of dimensions established by field measurement.
f. Relationship and attachment to adjoining construction clearly indicated.
g. Seal and signature of professional engineer if specified.

2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches but no larger than 30 by 42 inches.
3. Submit Shop Drawings in the following format:

a. PDF electronic file.
b. One opaque (bond) copies of each submittal.

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

1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
2. Identification: Attach label on unexposed side of Samples that includes the following:

a. Generic description of Sample.
b. Product name and name of manufacturer.
c. Sample source.
d. Number and title of applicable Specification Section.
e. Specification paragraph number and generic name of each item.

3. For projects where electronic submittals are required, provide corresponding electronic submittal of Sample transmittal, digital image file illustrating Sample characteristics, and identification information for record.
4. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.

a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.

5. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.

a. Number of Samples: Submit 1 set of samples to the Engineer and Owner for review.

1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.

E. Coordination Drawing Submittals: Comply with requirements specified in Section 01 31 00 - Project Management and Coordination.

F. Contractor's Construction Schedule: Comply with requirements specified in Section 01 32 00 - Construction Progress Documentation.

G. Application for Payment and Schedule of Values: Comply with requirements specified in Section 01 29 00 - Payment Procedures.

H. Test and Inspection Reports and Schedule of Tests and Inspections Submittals: Comply with requirements specified in Section 01 40 00 - Quality Requirements.

I. Closeout Submittals and Maintenance Material Submittals: Comply with requirements specified in Section 01 70 00 - Execution and Closeout Procedures.

J. Maintenance Data: Comply with requirements specified in Section 01 78 23 - Operation and Maintenance Data.

K. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of Engineers and owners, and other information specified.

L. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on AWS forms. Include names of firms and personnel certified.

M. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.

N. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.

O. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.

P. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.

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

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

S. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:

1. Name of evaluation organization.
2. Date of evaluation.
3. Time period when report is in effect.
4. Product and manufacturers' names.
5. Description of product.
6. Test procedures and results.
7. Limitations of use.

T. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.

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

V. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.

W. Design Data: Prepare and submit written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.

1.5 DELEGATED-DESIGN SERVICES

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.

1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Engineer.

B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF electronic file, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.

1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

A. Action and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Engineer.

B. Project Closeout and Maintenance Material Submittals: See requirements in Section 01 70 00 - Execution and Closeout Procedures.

C. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

3.2 ENGINEER'S ACTION

A. Action Submittals: Engineer will review each submittal, make marks to indicate corrections or revisions required, and return it. Engineer will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action.

B. Informational Submittals: Engineer will review each submittal and will not return it, or will return it if it does not comply with requirements. Engineer will forward each submittal to appropriate party.

C. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Engineer.

D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.

E. Submittals not required by the Contract Documents may be returned by the Engineer without action.

END OF SECTION 01 33 00

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 01 40 00 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Quality control.
2. Testing and inspection services.
3. Manufacturers' field services.
4. Shop Testing.
5. Field Testing.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

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

1. Specific quality-assurance and -control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and -control procedures that facilitate compliance with the Contract Document requirements.
3. Requirements for Contractor to provide quality-assurance and -control services required by Engineer, Owner, or authorities having jurisdiction are not limited by provisions of this Section.
4. Specific test and inspection requirements are not specified in this Section.

1.3 DEFINITIONS

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

B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Services do not include contract enforcement activities performed by Engineer.

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

D. Product Testing: Tests and inspections that are performed by an NRTL, an NVLAP, or a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.

E. Source Quality-Control Testing: Tests and inspections that are performed at the source, e.g., plant, mill, factory, or shop.

F. Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.

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

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

1. Use of trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade(s).

I. Experienced: When used with an entity or individual, "experienced" means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

1.4 INSPECTION AND TESTING LABORATORY SERVICES

A. Owner will employ and pay for the services of a Resident Project Representative (RPR)

B. Owner will employ and pay for the services of an independent testing laboratory to perform all specified services and testing related to the design of mixes, products and equipment, to Engineer's review of proposed materials and equipment before, during and after incorporation in the Work and to retest materials and equipment which fail original tests.

1. Employment of the laboratory shall in no way relieve Contractor's obligations to perform the Work of the Contract.
2. Retesting or re-inspection required because of nonconformance with specified or indicated requirements shall be performed by same independent firm on instructions from Engineer. Payment for retesting or re-inspection will be charged to Contractor by deducting testing charges from Contract Sum/Price.

1.5 ACCEPTABLE TESTING AGENCIES

A. Goodwyn Mills & Cawood; Montgomery, AL.

1.6 CONFLICTING REQUIREMENTS

A. Referenced Standards: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to Engineer for a decision before proceeding.

1.7 ACTION SUBMITTALS

1. Indicate manufacturer and model number of individual components.

1.8 INFORMATIONAL SUBMITTALS

A. Contractor's Quality-Control Plan: For quality-assurance and quality-control activities and responsibilities.

B. Qualification Data: For Contractor's quality-control personnel.

C. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility sent to authorities having jurisdiction before starting work on the following systems:

1. Seismic-force-resisting system, designated seismic system, or component listed in the designated seismic system quality-assurance plan prepared by Engineer.
2. Main wind-force-resisting system or a wind-resisting component listed in the wind-force-resisting system quality-assurance plan prepared by Engineer.

D. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.

E. Schedule of Tests and Inspections: Prepare in tabular form and include the following:

1. Specification Section number and title.
2. Entity responsible for performing tests and inspections.
3. Description of test and inspection.
4. Identification of applicable standards.
5. Identification of test and inspection methods.
6. Number of tests and inspections required.
7. Time schedule or time span for tests and inspections.
8. Requirements for obtaining samples.
9. Unique characteristics of each quality-control service.

1.9 CONTRACTOR'S QUALITY-CONTROL PLAN

A. Quality-Control Plan, General: Submit quality-control plan within 10 days of Notice to Proceed, and not less than five days prior to preconstruction conference. Submit in format acceptable to Engineer. Identify personnel, procedures, controls, instructions, tests, records, and forms to be

used to carry out Contractor's quality-assurance and quality-control responsibilities. Coordinate with Contractor's construction schedule.

B. Quality-Control Personnel Qualifications: Engage qualified personnel trained and experienced in managing and executing quality-assurance and quality-control procedures similar in nature and extent to those required for Project.

C. Submittal Procedure: Describe procedures for ensuring compliance with requirements through review and management of submittal process. Indicate qualifications of personnel responsible for submittal review.

D. Testing and Inspection: In quality-control plan, include a comprehensive schedule of Work requiring testing or inspection, including the following:

1. Contractor-performed tests and inspections including subcontractor-performed tests and inspections. Include required tests and inspections and Contractor-elected tests and inspections.
2. Special inspections required by authorities having jurisdiction and indicated on the "Statement of Special Inspections."
3. Owner-performed tests and inspections indicated in the Contract Document.

E. Continuous Inspection of Workmanship: Describe process for continuous inspection during construction to identify and correct deficiencies in workmanship in addition to testing and inspection specified. Indicate types of corrective actions to be required to bring work into compliance with standards of workmanship established by Contract requirements and approved mockups.

F. Monitoring and Documentation: Maintain testing and inspection reports including log of approved and rejected results. Include work Engineer has indicated as nonconforming or defective. Indicate corrective actions taken to bring nonconforming work into compliance with requirements. Comply with requirements of authorities having jurisdiction.

1.10 REPORTS AND DOCUMENTS

A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:

1. Date of issue.
2. Project title and number.
3. Name, address, and telephone number of testing agency.
4. Dates and locations of samples and tests or inspections.
5. Names of individuals making tests and inspections.
6. Description of the Work and test and inspection method.
7. Identification of product and Specification Section.
8. Complete test or inspection data.
9. Test and inspection results and an interpretation of test results.
10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.

12. Name and signature of laboratory inspector.
13. Recommendations on retesting and reinspection.

B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:

1. Name, address, and telephone number of technical representatives making report.
2. Statement on condition of substrates and their acceptability for installation of product.
3. Statement that products at Project site comply with requirements.
4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
6. Statement whether conditions, products, and installation will affect warranty.
7. Other required items indicated in individual Specification Sections.

C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:

1. Name, address, and telephone number of factory-authorized service representative making report.
2. Statement that equipment complies with requirements.
3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
4. Statement whether conditions, products, and installation will affect warranty.
5. Other required items indicated in individual Specification Sections.

D. Permits, Licenses, and Certificates: For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

1.11 QUALITY ASSURANCE

A. General: Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.

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

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

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

E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar in material, design, and extent to those indicated for this Project.

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

1. Requirements of authorities having jurisdiction shall supersede requirements for specialists.

G. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated; and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.

1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
2. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.

H. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

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

J. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities required to verify that the Work complies with requirements, whether specified or not.

1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
2. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.

    a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.

3. Notify testing agencies at least 48 hours in advance of time when Work that requires testing or inspecting will be performed.
4. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
5. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.

6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.

K. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 01 33 00 - Submittal Procedures.

L. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.

M. Retesting/Reinspection: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspection, for construction that replaced Work that failed to comply with the Contract Documents.

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

1. Notify Engineer and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
6. Do not perform any duties of Contractor.

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

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

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

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

Q. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents as a component of Contractor's quality-control plan. Coordinate and submit concurrently with Contractor's construction schedule. Update as the Work progresses.

1. Distribution: Distribute schedule to Owner, Engineer, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:

1. Date test or inspection was conducted.
2. Description of the Work tested or inspected.
3. Date test or inspection results were transmitted to Engineer.
4. Identification of testing agency or special inspector conducting test or inspection.

B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Engineer's reference during normal working hours.

3.2 REPAIR AND PROTECTION

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

1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 01 70 00 - Execution and Closeout Requirements.

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

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

END OF SECTION 01 40 00

SECTION 01 40 10 - MATERIALS TESTING

PART 1 - GENERAL

1.1 GENERAL REQUIRMENTS

A. The following information regarding Employment of and Payment for Testing Services under the work of Specifications shall take precedence over any conflicting statement otherwise, which may have remained in the Project Manual after editing:

1. Initial testing required by the Contract Documents for Divisions 3 and 31 shall be provided by a testing agency pre-approved by the Owner & Contractor, and employed, and paid by the Contractor.

    a. Other testing required shall be performed by an independent third-party testing agency, and at the Contractor's expense.

2. Any retesting required (due to questionable materials or construction methods, for verification purposes, and etc.) shall be at the Contractor's expense when the results of such retesting indicate any work or materials do not comply with requirements of the Contract Documents.
3. Any retesting under the above provisions shall be performed by the same Owner accepted testing agency.

B. The Contractor shall be responsible for contacting and directions to the accepted testing agency and for any follow-up communications required, for all testing required by the Contract Documents. Contractor shall copy Engineer on all materials testing correspondence and testing results.

C. No unsuitable or unsatisfactory existing soils or building materials (other than work in Contract) shall be removed without either the presence of or concurrence of and prior approval of the Engineer and the accepted testing agency, so as to assure quality of the Work is maintained.

D. All materials testing (geotechnical, concrete, etc.) shall be paid for by the Contractor and included in the base bid as incidental to the work.

E. Contractor shall be required to have geotechnical analysis performed on any fill material to ensure it meets the earthwork/backfill specifications.

PART 2 - PRODUCTS – (Not Used)

PART 3 - EXECUTION – (Not Used)

END OF SECTION 01 40 10

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 01 50 00 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes requirements for temporary utilities, support facilities, and security and protection facilities.

B. Related Requirements:

1. Section 01 10 00 – Summary, for work restrictions and limitations on utility interruptions.
2. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

1.2 USE CHARGES

A. General: Installation and removal of and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities to use temporary services and facilities without cost, including, but not limited to Engineer, testing agencies, and authorities having jurisdiction.

B. Sewer Service: Sewer service use charges shall be by the Contractor utilizing portable facilities.

C. Water Service: Water-service use charges for water used by all entities for construction operations shall be by the Contractor.

D. Electric Power Service: Electric-power-service use charges for electricity used by all entities for construction operations shall be by the Contractor.

1.3 INFORMATIONAL SUBMITTALS

A. Site Plan: Show temporary facilities, utility hookups, staging areas, and parking areas for construction personnel.

B. Erosion- and Sedimentation-Control Plan: Show compliance with requirements of EPA Construction General Permit or authorities having jurisdiction (ADEM), whichever is more stringent.

1.4 QUALITY ASSURANCE

A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.

B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

1.5 PROJECT CONDITIONS

A. Temporary Use of Permanent Facilities: Engage Installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.

PART 2 - PRODUCTS

2.1 TEMPORARY FACILITIES

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

B. Common-Use Field Office: Of sufficient size to accommodate needs of Engineer and construction personnel office activities and to accommodate Project meetings specified in other Division 01 Sections. Keep office clean and orderly.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.

B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.2 TEMPORARY UTILITY INSTALLATION

A. General: Install temporary service or connect to existing service.

1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.

B. Sewers and Drainage: Provide temporary utilities to remove effluent lawfully.

1. Connect temporary sewers to system as directed by authorities having jurisdiction.

C. Water Service: Install water service and distribution piping in sizes and pressures adequate for construction.

D. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.

E. Heating and Cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.

F. Isolation of Work Areas in Occupied Facilities: Prevent dust, fumes, and odors from entering occupied areas.

G. Ventilation and Humidity Control: Provide temporary ventilation required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce ambient condition required and minimize energy consumption.

1. Provide dehumidification systems when required to reduce substrate moisture levels to level required to allow installation or application of finishes.

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

1. Install electric power service overhead or underground or as indicated.

I. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.

1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.

3.3 SUPPORT FACILITIES INSTALLATION

A. General: Comply with the following:

1. Maintain support facilities until Engineer schedules Substantial Completion inspection. Remove before Final Completion.

B. Temporary Roads and Paved Areas: Construct and maintain temporary roads and paved areas adequate for construction operations. Locate temporary roads and paved areas within construction limits indicated on Drawings.

1. Provide dust-control treatment that is nonpolluting and nontracking. Reapply treatment as required to minimize dust.

C. Temporary Use of Permanent Roads and Paved Areas: Locate temporary roads and paved areas in same location as permanent roads and paved areas. Construct and maintain temporary roads and paved areas adequate for construction operations. Extend temporary roads and paved areas, within construction limits indicated, as necessary for construction operations.

1. Coordinate elevations of temporary roads and paved areas with permanent roads and paved areas.
2. Prepare subgrade and install subbase and base for temporary roads.
3. Recondition base after temporary use, including removing contaminated material, regrading, proofrolling, compacting, and testing.
4. Delay installation of final course of permanent hot-mix asphalt pavement until immediately before Substantial Completion. Repair hot-mix asphalt base-course pavement before installation of final course according to Section 32 12 16 - Asphalt Paving.

D. Traffic Controls: Comply with requirements of authorities having jurisdiction.

1. Protect existing site improvements to remain including curbs, pavement, and utilities.
2. Maintain access for fire-fighting equipment and access to fire hydrants.

E. Parking: Provide temporary parking areas for construction personnel.

F. Project Signs: Provide Project signs as indicated. Unauthorized signs are not permitted. Subcontractors are not authorized to have signage.

1. Identification Signs: Provide Project identification signs as indicated on Drawings.
2. Temporary Signs: Provide other signs as indicated and as required to inform public and individuals seeking entrance to Project.

    a. Provide temporary construction signs as required by funding agencies.
    b. Provide temporary, directional signs for construction personnel and visitors.

3. Maintain and touchup signs so they are legible at all times.

G. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction. Comply with progress cleaning requirements in Section 01 70 00 - Execution and Closeout Requirements.

H. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.

3.4 SECURITY AND PROTECTION FACILITIES INSTALLATION

A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities.

B. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.

1. Comply with work restrictions specified in Section 01 10 00 - Summary.

C. Temporary Erosion and Sedimentation Control: Comply with authorities having jurisdiction, and requirements specified in Section 31 25 00 - Erosion and Sedimentation Controls.

D. Stormwater Control: Comply with requirements of authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.

E. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.

F. Temporary Egress: Maintain temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction.

G. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.

1. Where heating or cooling is needed and permanent enclosure is incomplete, insulate temporary enclosures.
2. Where fire-resistance-rated temporary partitions are indicated or are required by authorities having jurisdiction, construct partitions according to the rated assemblies
3. Insulate partitions to control noise transmission to occupied areas.
4. Seal joints and perimeter. Equip partitions with gasketed dustproof doors and security locks where openings are required.
5. Protect air-handling equipment.
6. Provide walk-off mats at each entrance through temporary partition.

3.5 MOISTURE AND MOLD CONTROL

A. Contractor's Moisture-Protection Plan: Avoid trapping water in finished work. Document visible signs of mold that may appear during construction.

B. Exposed Construction Phase: Before installation of weather barriers, when materials are subject to wetting and exposure and to airborne mold spores, protect as follows:

1. Protect porous materials from water damage.
2. Protect stored and installed material from flowing or standing water.
3. Keep porous and organic materials from coming into prolonged contact with concrete.
4. Remove standing water from decks.
5. Keep deck openings covered or dammed.

C. Partially Enclosed Construction Phase: After installation of weather barriers but before full enclosure and conditioning of building, when installed materials are still subject to infiltration of moisture and ambient mold spores, protect as follows:

1. Do not load or install drywall or other porous materials or components, or items with high organic content, into partially enclosed building.
2. Keep interior spaces reasonably clean and protected from water damage.
3. Periodically collect and remove waste containing cellulose or other organic matter.
4. Discard or replace water-damaged material.
5. Do not install material that is wet.
6. Discard, replace, or clean stored or installed material that begins to grow mold.

7. Perform work in a sequence that allows any wet materials adequate time to dry before enclosing the material in drywall or other interior finishes.

3.6 OPERATION, TERMINATION, AND REMOVAL

A. Maintenance: Maintain facilities in good operating condition until removal.

1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.

B. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.

C. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.

1. Materials and facilities that constitute temporary facilities are property of Contractor. Owner reserves right to take possession of Project identification signs.
2. Remove temporary roads and paved areas not intended for or acceptable for integration into permanent construction. Where area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at temporary entrances, as required by authorities having jurisdiction.
3. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 01 70 00 - Execution and Closeout Requirements.

END OF SECTION 01 50 00

SECTION 01 60 00 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.3 DEFINITIONS

A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.

1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature, that is current as of date of the Contract Documents.
2. New Products: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.
3. Comparable Product: Product that is demonstrated and approved through submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.

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

1.4 ACTION SUBMITTALS

A. Comparable Product Requests: Submit request for consideration of each comparable product. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.

1. Include data to indicate compliance with the requirements specified in "Comparable Products" Article.

2. Engineer's Action: If necessary, Engineer will request additional information or documentation for evaluation within one week of receipt of a comparable product request. Engineer will notify Contractor of approval or rejection of proposed comparable product request within 15 days of receipt of request, or 7 days of receipt of additional information or documentation, whichever is later.

    a. Form of Approval: As specified in Section 01 33 00 - Submittal Procedures.
    b. Use product specified if Engineer does not issue a decision on use of a comparable product request within time allocated.

B. Basis-of-Design Product Specification Submittal: Comply with requirements in Section 01 33 00 - Submittal Procedures. Show compliance with requirements.

1.5 QUALITY ASSURANCE

A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.

B. Delivery and Handling:

1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
4. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.

C. Storage:

1. Store products to allow for inspection and measurement of quantity or counting of units.
2. Store materials in a manner that will not endanger Project structure.
3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
4. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
5. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
6. Protect stored products from damage and liquids from freezing.

1.7 PRODUCT WARRANTIES

A. Warranty requirements shall conform with the General Conditions followed by Specification Section 01 10 00.

1.8 PRODUCT SELECTION PROCEDURES

A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.

1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
4. Where products are accompanied by the term "as selected," Engineer will make selection.
5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
6. Or Equal: For products specified by name and accompanied by the term "or equal," or "or approved equal," or "or approved," comply with requirements in "Comparable Products" Article and/or Section 01 25 00 – Substitution of Major Equipment Items to obtain approval for use of an unnamed product.

B. Product Selection Procedures:

1. Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
2. Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
3. Products:

    a. Restricted List: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will be considered.

4. Manufacturers:

    a. Restricted List: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will be considered,

5. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.

C. Visual Matching Specification: Where Specifications require "match Engineer's sample", provide a product that complies with requirements and matches Engineer's sample. Engineer's decision will be final on whether a proposed product matches.

1. If no product available within specified category matches and complies with other specified requirements, comply with requirements in Section 01 25 00 - Substitution of Major Equipment Items and Products for proposal of product.

D. Visual Selection Specification: Where Specifications include the phrase "as selected by Engineer from manufacturer's full range" or similar phrase, select a product that complies with requirements. Engineer will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

1.9 COMPARABLE PRODUCTS

A. Conditions for Consideration: Engineer will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Engineer may return requests without action, except to record noncompliance with these requirements:

1. Evidence that the proposed product does not require revisions to the Contract Documents, that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.
2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
3. Evidence that proposed product provides specified warranty.
4. List of similar installations for completed projects with project names and addresses and names and addresses of Engineers and owners, if requested.
5. Samples, if requested.
6. The Contractor shall also include in the price bid the modifications necessary for the comparable product to be utilized. This includes but is not limited to, electrical and mechanical changes, engineering time to assess the changes, modifications to buildings, programmable controls and structural modifications.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 60 00

SECTION 01 70 00 - EXECUTION AND CLOSEOUT REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Field engineering.
2. Closeout procedures.
3. Starting of systems.
4. Demonstration and instructions.
5. Testing, adjusting, and balancing.
6. Project record documents.
7. Operation and maintenance data.
8. Manual for materials and finishes.
9. Manual for equipment and systems.
10. Spare parts and maintenance products.
11. Product warranties and product bonds.
12. Examination.
13. Preparation.
14. Execution.
15. Cutting and patching.
16. Protecting installed construction.
17. Final cleaning.

B. Related Requirements:

1. Section 01 33 00 - Submittal Procedures, for submitting copies of submittals for operation and maintenance manuals.
2. Section 01 78 23 - Operation and Maintenance Data, for submitting operation and maintenance manuals.

1.2 FIELD ENGINEERING

A. Employ land surveyor registered in state of Alabama acceptable to Engineer.

B. Locate protect survey control and reference points. Promptly notify Engineer of discrepancies discovered.

C. Control datum for survey is indicated on Drawings.

D. Verify setbacks and easements; confirm Drawing dimensions and elevations.

E. Provide field engineering services. Establish elevations, lines, and levels using recognized engineering survey practices.

F. Protect survey control points prior to starting Site Work; preserve permanent reference points during construction.

G. Replace dislocated survey control points based on original survey control. Make no changes without prior written notice to Engineer

1.3 CLOSEOUT PROCEDURES

A. Prerequisites to Substantial Completion: Complete following items before requesting Certification of Substantial Completion, either for entire Work or for portions of Work:

1. Submit operation and maintenance manuals, Project record documents, and other similar final record data in compliance with this Section.
2. Complete facility startup, testing, adjusting, balancing of systems and equipment, demonstrations, and instructions to Owner's operating and maintenance personnel as specified in compliance with this Section.
3. Conduct inspection to establish basis for request that Work is substantially complete. Create comprehensive list (initial punch list) indicating items to be completed or corrected, value of incomplete or nonconforming Work, reason for being incomplete, and date of anticipated completion for each item. Include copy of list with request for Certificate of Substantial Completion.
4. Obtain and submit releases enabling Owner's full, unrestricted use of Project and access to services and utilities. Include certificate of occupancy, operating certificates, and similar releases from authorities having jurisdiction and utility companies.
5. Deliver tools, spare parts, extra stocks of material, and similar physical items to Owner.
6. Make final change-over in security provisions.
7. Discontinue or change over and remove temporary facilities and services from Project Site, along with construction tools, mockups, and similar elements.
8. Perform final cleaning according to this Section.

B. Substantial Completion Inspection:

1. When Contractor considers Work to be substantially complete, submit to Engineer:

    a. Written certificate that Work, or designated portion, is substantially complete.
    b. List of items to be completed or corrected (initial punch list).

2. Within seven days after receipt of request for Substantial Completion, Engineer will make inspection to determine whether Work or designated portion is substantially complete.
3. Should Engineer determine that Work is not substantially complete:

    a. Engineer will promptly notify Contractor in writing, stating reasons for its opinion.
    b. Contractor shall remedy deficiencies in Work and send second written request for Substantial Completion to Engineer.
    c. Engineer will re-inspect Work.
    d. Redo and Inspection of Deficient Work: Repeated until Work passes Engineer and Owner’s inspection.

4. When Engineer finds that Work is substantially complete, Engineer will:

a. Prepare Certificate of Substantial Completion on EJCDC C-625 - Certificate of Substantial Completion accompanied by Contractor's list of items to be completed or corrected as verified and amended by Engineer and Owner (final punch list).
b. Submit Certificate to Owner and Contractor for their written acceptance of responsibilities assigned to them in Certificate.

5. After Work is substantially complete, Contractor shall:

a. Allow Owner occupancy of Project under provisions stated in Certificate of Substantial Completion.
b. Complete Work listed for completion or correction within time period stipulated.

C. Prerequisites for Final Completion: Complete following items before requesting final acceptance and final payment.

1. When Contractor considers Work to be complete, submit written certification that:

a. Contract Documents have been reviewed.
b. Work has been examined for compliance with Contract Documents.
c. Work has been completed according to Contract Documents.
d. Work is completed and ready for final inspection.

2. Submittals: Submit following:

a. Final punch list indicating all items have been completed or corrected.
b. Final payment request with final releases and supporting documentation not previously submitted and accepted. Include certificates of insurance for products and completed operations where required.
c. Specified warranties, workmanship/maintenance bonds, maintenance agreements, and other similar documents.
d. Accounting statement for final changes to Contract Sum.
e. Contractor's affidavit of payment of debts.
f. Contractor affidavit of release of liens.
g. Consent of surety to final payment.

3. Perform final cleaning for Contractor-soiled areas according to this Section.

D. Final Completion Inspection:

1. Within seven days after receipt of request for final inspection, Owner and Engineer will make inspection to determine whether Work or designated portion is complete.
2. Should Engineer consider Work to be incomplete or defective:

a. Engineer will promptly notify Contractor in writing, listing incomplete or defective Work.
b. Contractor shall remedy stated deficiencies and send second written request to Work is complete.
c. Engineer will re-inspect Work.
d. Redo and Inspection of Deficient Work: Repeated until Work passes inspection.

1.4 STARTING OF SYSTEMS

A. Coordinate schedule for startup of various equipment and systems.

B. Notify Engineer and owner seven days prior to startup of each item.

C. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions which may cause damage.

D. Verify that tests, meter readings, and electrical characteristics agree with those required by equipment or system manufacturer.

E. Verify that wiring and support components for equipment are complete and tested.

F. Execute startup under supervision of manufacturer's representative or Contractors' personnel according to manufacturer's instructions.

G. When specified in individual Specification Sections, require manufacturer to provide authorized representative who will be present at Site to inspect, check, and approve equipment or system installation prior to startup and will supervise placing equipment or system in operation.

H. Submit a written report that equipment or system has been properly installed and is functioning correctly, as well as a certificate/field report from the manufacturer from his inspection of the installation.

1.5 DEMONSTRATION AND INSTRUCTIONS

A. Demonstrate operation and maintenance of products to Owner's personnel as equipment becomes available for use and not later than fourteen (14) days prior to date of Substantial Completion.

B. Demonstrate project equipment at the facility. Demonstration shall be instructed by qualified manufacturer’s representative who is knowledgeable about the project.

C. Use operation and maintenance manuals as basis for instruction. Review contents of manual with Owner's personnel in detail to explain all aspects of operation and maintenance.

D. Demonstrate startup, operation, control, adjustment, troubleshooting, servicing, maintenance, and shutdown of each item of equipment at scheduled time, at designated location.

E. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.

1.6 TESTING, ADJUSTING, AND BALANCING

A. Contractor with Engineer approval will appoint and employ services of independent firm to perform testing, adjusting, and balancing. Contractor shall pay for services.

B. Reports will be submitted by independent firm to Engineer indicating observations and results of tests and indicating compliance or noncompliance with requirements of Contract Documents.

1.7 PROJECT RECORD DOCUMENTS

A. Maintain on Site one set of the following record documents; record actual revisions to the Work:

1. Drawings.
2. Specifications.
3. Addenda.
4. Change Orders and other modifications to the Contract.
5. Reviewed Shop Drawings, product data, and Samples.
6. Manufacturer's instruction for assembly, installation, and adjusting.

B. Ensure entries are complete and accurate, enabling future reference by Owner.

C. Store record documents separate from documents used for construction.

D. Record information concurrent with construction progress, not less than weekly.

E. Specifications: Legibly mark and record, at each product Section, description of actual products installed, including the following:

1. Manufacturer's name and product model and number.
2. Product substitutions or alternates used.
3. Changes made by Addenda and modifications.

F. Record Drawings: Legibly mark each item to record actual construction as follows:

1. Include Contract modifications such as Addenda, supplementary instructions, change directives, field orders, minor changes in the Work, and change orders.
2. Include locations of concealed elements of the Work.
3. Identify depth of buried utility lines and provide dimensions showing distances from permanent facility components that are parallel to utilities.
4. Dimension ends, corners, and junctions of buried utilities to permanent facility components using triangulation.
5. Identify and locate existing buried or concealed items encountered during Project.
6. Measured depths of foundations in relation to finish floor datum.
7. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
8. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
9. Field changes of dimension and detail.
10. Details not on original Drawings.

G. Submit marked-up paper copy documents to Engineer with claim for final Application for Payment.

1.8 OPERATION AND MAINTENANCE DATA

A. See Section 01 78 23 - Operation and Maintenance Data for operation and maintenance manuals.

PART 2 - PRODUCTS - Not Used

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that existing Site conditions and substrate surfaces are acceptable for subsequent Work. Beginning new Work means acceptance of existing conditions.

B. Verify that existing substrate is capable of structural support or attachment of new Work being applied or attached.

C. Examine and verify specific conditions described in individual Specification Sections.

D. Verify that utility services are available with correct characteristics and in correct locations.

3.2 PREPARATION

A. Clean substrate surfaces prior to applying next material or substance according to manufacturer's instructions.

B. Seal cracks or openings of substrate prior to applying next material or substance.

C. Apply manufacturer-required or -recommended substrate primer, sealer, or conditioner prior to applying new material or substance in contact or bond.

3.3 EXECUTION

A. Comply with manufacturer's installation instructions, performing each step in sequence. Maintain one set of manufacturer's installation instructions at Project Site during installation and until completion of construction.

B. When manufacturer's installation instructions conflict with Contract Documents, request clarification from Engineer before proceeding.

C. Verify that field measurements are as indicated on approved Shop Drawings or as instructed by manufacturer.

D. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.

1. Secure Work true to line and level and within specified tolerances, or if not specified, industry-recognized tolerances.
2. Physically separate products in place, provide electrical insulation, or provide protective coatings to prevent galvanic action or corrosion between dissimilar metals.
3. Exposed Joints: Provide uniform joint width and arrange to obtain best visual effect. Refer questionable visual-effect choices to Engineer for final decision.

E. Allow for expansion of materials and building movement.

F. Climatic Conditions and Project Status: Install each unit of Work under conditions to ensure best possible results in coordination with entire Project.

1. Isolate each unit of Work from incompatible Work as necessary to prevent deterioration.
2. Coordinate enclosure of Work with required inspections and tests to minimize necessity of uncovering Work for those purposes.

G. Mounting Heights: Where not indicated, mount individual units of Work at industry recognized standard mounting heights for particular application indicated.

1. Refer questionable mounting heights choices to Engineer for final decision.

H. Adjust operating products and equipment to ensure smooth and unhindered operation.

I. Clean and perform maintenance on installed Work as frequently as necessary through remainder of construction period. Lubricate operable components as recommended by manufacturer.

3.4 CUTTING AND PATCHING

A. Employ skilled and experienced installers to perform cutting and patching.

B. Submit written request in advance of cutting or altering elements affecting:

1. Structural integrity of element.
2. Integrity of weather-exposed or moisture-resistant elements.
3. Efficiency, maintenance, or safety of element.
4. Visual qualities of sight-exposed elements.
5. Work of Owner or separate contractor.

C. Execute cutting, fitting, and patching including excavation and fill to complete Work and to:

1. Fit the several parts together, to integrate with other Work.
2. Uncover Work to install or correct ill-timed Work.
3. Remove and replace defective and nonconforming Work.
4. Remove samples of installed Work for testing.
5. Provide openings in elements of Work for penetrations of mechanical and electrical Work.

D. Execute Work by methods to avoid damage to other Work and to provide proper surfaces to receive patching and finishing.

E. Cut masonry and concrete materials using masonry saw or core drill.

F. Restore Work with new products according to requirements of Contract Documents.

G. Fit Work tight to pipes, sleeves, ducts, conduits, and other penetrations through surfaces.

H. Maintain integrity of wall, ceiling, or floor construction; completely seal voids.

I. At penetrations of fire-rated walls, partitions, ceiling, or floor construction, completely seal voids with fire-rated material to full thickness of penetrated element.

J. Refinish surfaces to match adjacent finishes. For continuous surfaces, refinish to nearest intersection; for assembly, refinish entire unit.

K. Identify hazardous substances or conditions exposed during the Work to Engineer for decision or remedy.

3.5 PROTECTING INSTALLED CONSTRUCTION

A. Protect installed Work and provide special protection where specified in individual Specification Sections.

B. Provide temporary and removable protection for installed products. Control activity in immediate Work area to prevent damage.

C. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.

D. Use durable sheet materials to protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects.

E. Prohibit traffic or storage upon waterproofed or roofed surfaces. When traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.

F. Prohibit traffic from landscaped areas.

3.6 FINAL CLEANING

A. Execute final cleaning prior to final Project assessment.

1. Employ experienced personnel or professional cleaning firm.

B. Clean interior and exterior glass and surfaces exposed to view; remove temporary labels, stains, and foreign substances; polish transparent and glossy surfaces, and vacuum carpeted and soft surfaces.

C. Clean equipment and fixtures to sanitary condition with appropriate cleaning materials.

D. Clean debris from roofs, gutters, downspouts, and drainage systems.

E. Clean Site; sweep paved areas, rake clean landscaped surfaces.

F. Remove waste and surplus materials, rubbish, and construction facilities from Site.

END OF SECTION 01 70 00

SECTION 01 78 23 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:

1. Operation and maintenance documentation directory.
2. Emergency manuals.
3. Operation manuals for systems, subsystems, and equipment.
4. Product maintenance manuals.
5. Systems and equipment maintenance manuals.

B. Related Requirements:

1. Section 01 33 00 - Submittal Procedures, for submitting copies of submittals for operation and maintenance manuals.

1.2 DEFINITIONS

A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.

B. Subsystem: A portion of a system with characteristics similar to a system.

1.3 CLOSEOUT SUBMITTALS

A. Manual Content: Operations and maintenance manual content is specified in individual Specification Sections to be reviewed at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.

1. Engineer will comment on whether content of operations and maintenance submittals are acceptable.
2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.

B. Format: Submit operations and maintenance manuals in the following format:

1. PDF electronic file. Assemble each manual into a composite electronically indexed file. Submit on digital media acceptable to Engineer.

a. Name each indexed document file in composite electronic index with applicable item name. Include a complete electronically linked operation and maintenance directory.
b. Enable inserted reviewer comments on draft submittals.

2. Two paper copies. Include a complete operation and maintenance directory. Enclose title pages and directories in clear plastic sleeves.

C. Final Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least 15 days before commencing demonstration and training. Engineer will return copy with comments.

1. Correct or revise each manual to comply with Engineer's comments. Submit copies of each corrected manual within 15 days of receipt of Engineer's comments and prior to commencing demonstration and training.

PART 2 - PRODUCTS

2.1 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY

A. Directory: Prepare a single, comprehensive directory of emergency, operation, and maintenance data and materials, listing items and their location to facilitate ready access to desired information. Include a section in the directory for each of the following:

1. List of documents.
2. List of systems.
3. List of equipment.
4. Table of contents.

B. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.

C. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of system, list alphabetically in separate list.

D. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.

E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."

2.2 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

A. Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:

1. Title page.
2. Table of contents.
3. Manual contents.

B. Title Page: Include the following information:

1. Subject matter included in manual.
2. Name and address of Project.
3. Name and address of Owner.
4. Date of submittal.
5. Name and contact information for Contractor.
6. Name and contact information for Construction Manager.
7. Name and contact information for Engineer.
8. Names and contact information for major consultants to the Engineer that designed the systems contained in the manuals.
9. Cross-reference to related systems in other operation and maintenance manuals.

C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.

1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.

D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.

E. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.

1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
2. File Names and Bookmarks: Enable bookmarking of individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.

F. Manuals, Paper Copy: Submit manuals in the form of hard copy, bound and labeled volumes.

1. Binders: Heavy-duty, three-ring, vinyl-covered, binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch and 11 x 17 paper (Z folded); with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.

a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary, to provide essential information for proper operation or maintenance of equipment or system.

b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name and subject matter of contents, and indicate Specification Section number on bottom of spine. Indicate volume number for multiple-volume sets.

2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
3. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.

   a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
   b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

2.3 OPERATION MANUALS

A. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:

1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
2. Performance and design criteria if Contractor has delegated design responsibility.
3. Operating standards.
4. Operating procedures.
5. Operating logs.
6. Wiring diagrams.
7. Control diagrams.
8. Piped system diagrams.
9. Precautions against improper use.
10. License requirements including inspection and renewal dates.

B. Descriptions: Include the following:

1. Product name and model number. Use designations for products indicated on Contract Documents.
2. Manufacturer's name.
3. Equipment identification with serial number of each component.
4. Equipment function.
5. Operating characteristics.
6. Limiting conditions.
7. Performance curves.
8. Engineering data and tests.
9. Complete nomenclature and number of replacement parts.

C. Operating Procedures: Include the following, as applicable:

1. Startup procedures.
2. Equipment or system break-in procedures.
3. Routine and normal operating instructions.
4. Regulation and control procedures.
5. Instructions on stopping.
6. Normal shutdown instructions.
7. Seasonal and weekend operating instructions.
8. Required sequences for electric or electronic systems.
9. Special operating instructions and procedures.

D. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

E. Piped Systems: Diagram piping as installed, and identify color-coding where required for identification.

2.4 PRODUCT MAINTENANCE MANUALS

A. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.

B. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

C. Product Information: Include the following, as applicable:

1. Product name and model number.
2. Manufacturer's name.
3. Color, pattern, and texture.
4. Material and chemical composition.
5. Reordering information for specially manufactured products.

D. Maintenance Procedures: Include manufacturer's written recommendations and the following:

1. Inspection procedures.
2. Types of cleaning agents to be used and methods of cleaning.
3. List of cleaning agents and methods of cleaning detrimental to product.
4. Schedule for routine cleaning and maintenance.
5. Repair instructions.

E. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.

F. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

1. Include procedures to follow and required notifications for warranty claims.

2.5 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

A. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.

B. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

C. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:

1. Standard maintenance instructions and bulletins.
2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
3. Identification and nomenclature of parts and components.
4. List of items recommended to be stocked as spare parts.

D. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:

1. Test and inspection instructions.
2. Troubleshooting guide.
3. Precautions against improper maintenance.
4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
5. Aligning, adjusting, and checking instructions.
6. Demonstration and training video recording, if available.

E. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.

1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.

F. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.

G. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.

H. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

1. Include procedures to follow and required notifications for warranty claims.

PART 3 - EXECUTION

3.1 MANUAL PREPARATION

A. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.

B. Operation and Maintenance Manuals: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.

1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.

C. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.

1. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.

D. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.

1. Do not use original project record documents as part of operation and maintenance manuals.
2. Comply with requirements of newly prepared Record Drawings in Section 01 78 39 - Project Record Documents.

E. Comply with Section 01 70 00 - Execution and Closeout Procedures for schedule for submitting operation and maintenance documentation.

END OF SECTION 01 78 23

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 01 78 39 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for project record documents, including the following:

1. Record Drawings.
2. Record Specifications.
3. Record Product Data.
4. Miscellaneous record submittals.

B. Related Requirements:

1. Section 01 70 00 - Execution and Closeout Procedures, for general closeout procedures.
2. Section 01 78 23 - Operation and Maintenance Data, for operation and maintenance manual requirements.

1.2 CLOSEOUT SUBMITTALS

A. Record Drawings: Comply with the following:

1. Submit copies of marked-up record prints as follows:

a. Initial Submittal:

1) Submit electronic files or one (1) hard copy set. Engineer will review and return, with comments as necessary.

b. Final Submittal:

1) After incorporation of Engineer's comments, submit electronic files and one (1) hard copy set of final marked-up record prints to the Engineer and electronic files and one (1) hard copy set to the Owner.

c. Engineer will be responsible for generating record drawings based on the Contractor's marked-up record prints and delivering three (3) hard copy sets to the Owner.

B. Miscellaneous Record Submittals: See other Specification Sections for miscellaneous record-keeping requirements and submittals in connection with various construction activities.

PART 2 - PRODUCTS

2.1 RECORD DRAWINGS

A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued. Contractor shall maintain a set of marked up prints on the job site for review prior to pay request approval.

1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.

    a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
    b. Accurately record information in an acceptable drawing technique.
    c. Record data as soon as possible after obtaining it.
    d. Record and check the markup before enclosing concealed installations.
    e. Cross-reference record prints to corresponding archive photographic documentation.

2. Content: Types of items requiring marking include, but are not limited to, the following:

    a. Dimensional changes to Drawings.
    b. Revisions to details shown on Drawings.
    c. Depths of foundations below first floor.
    d. Locations and depths of underground utilities.
    e. Revisions to routing of piping and conduits.
    f. Revisions to electrical circuitry.
    g. Actual equipment locations.
    h. Duct size and routing.
    i. Locations of concealed internal utilities.
    j. Changes made by Change Order or Work Change Directive.
    k. Changes made following Engineer's written orders.
    l. Details not on the original Contract Drawings.
    m. Field records for variable and concealed conditions.
    n. Record information on the Work that is shown only schematically.

3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
5. Mark important additional information that was either shown schematically or omitted from original Drawings.
6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.

B. Format: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.

1. Record Prints: Organize record prints and newly prepared record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
2. Format: Annotated PDF electronic file with comment function enabled.
3. Record Digital Data Files: Organize digital data information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each digital data file.
4. Identification: As follows:

    a. Project name.
    b. Date.
    c. Designation "PROJECT RECORD DRAWINGS."
    d. Name of Engineer.
    e. Name of Contractor.

2.2 MISCELLANEOUS RECORD SUBMITTALS

A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

B. Format: Submit miscellaneous record submittals as PDF electronic file.

1. Include miscellaneous record submittals directory organized by Specification Section number and title, electronically linked to each item of miscellaneous record submittals.

PART 3 - EXECUTION

3.1 RECORDING AND MAINTENANCE

A. Recording: Maintain one copy of each submittal during the construction period for project record document purposes. Post changes and revisions to project record documents as they occur; do not wait until end of Project.

B. Maintenance of Record Documents and Samples: Store record documents and Samples in the field office apart from the Contract Documents used for construction. Do not use project record documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project record documents for Engineer's reference during normal working hours.

END OF SECTION 01 78 39

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 01 79 00 - DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:

1. Demonstration of operation of systems, subsystems, and equipment.
2. Training in operation and maintenance of systems, subsystems, and equipment.

B. Furnish demonstration and training instruction time as a subsidiary obligation of the price bid.

C. Related Requirements

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 QUALITY ASSURANCE

A. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.

B. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Section 01 40 00 - Quality Requirements, experienced in operation and maintenance procedures and training.

1.3 COORDINATION

A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of Owner's personnel.

B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.

C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by Engineer.

PART 2 - PRODUCTS

2.1 INSTRUCTION PROGRAM

A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.

B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:

1. Basis of System Design, Operational Requirements, and Criteria: Include the following:

    a. System, subsystem, and equipment descriptions.
    b. Performance and design criteria if Contractor has delegated design responsibility.
    c. Operating standards.
    d. Regulatory requirements.
    e. Equipment function.
    f. Operating characteristics.
    g. Limiting conditions.
    h. Performance curves.

2. Documentation: Review the following items in detail:

    a. Emergency manuals.
    b. Operations manuals.
    c. Maintenance manuals.
    d. Project record documents.
    e. Identification systems.
    f. Warranties and bonds.
    g. Maintenance service agreements and similar continuing commitments.

3. Emergencies: Include the following, as applicable:

    a. Instructions on meaning of warnings, trouble indications, and error messages.
    b. Instructions on stopping.
    c. Shutdown instructions for each type of emergency.
    d. Operating instructions for conditions outside of normal operating limits.
    e. Sequences for electric or electronic systems.
    f. Special operating instructions and procedures.

4. Operations: Include the following, as applicable:

    a. Startup procedures.
    b. Equipment or system break-in procedures.
    c. Routine and normal operating instructions.
    d. Regulation and control procedures.
    e. Control sequences.

f. Safety procedures.
g. Instructions on stopping.
h. Normal shutdown instructions.
i. Operating procedures for emergencies.
j. Operating procedures for system, subsystem, or equipment failure.
k. Seasonal and weekend operating instructions.
l. Required sequences for electric or electronic systems.
m. Special operating instructions and procedures.

5. Adjustments: Include the following:

a. Alignments.
b. Checking adjustments.
c. Noise and vibration adjustments.
d. Economy and efficiency adjustments.

6. Troubleshooting: Include the following:

a. Diagnostic instructions.
b. Test and inspection procedures.

7. Maintenance: Include the following:

a. Inspection procedures.
b. Types of cleaning agents to be used and methods of cleaning.
c. List of cleaning agents and methods of cleaning detrimental to product.
d. Procedures for routine cleaning
e. Procedures for preventive maintenance.
f. Procedures for routine maintenance.
g. Instruction on use of special tools.

8. Repairs: Include the following:

a. Diagnosis instructions.
b. Repair instructions.
c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
d. Instructions for identifying parts and components.
e. Review of spare parts needed for operation and maintenance.

PART 3 - EXECUTION

3.1 PREPARATION

A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Section 01 78 23 - Operation and Maintenance Data.

B. Set up instructional equipment at instruction location.

3.2 INSTRUCTION

A. Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and Owner for number of participants, instruction times, and location.

B. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.

1. Engineer will furnish an instructor to describe basis of system design, operational requirements, criteria, and regulatory requirements.
2. Owner will furnish an instructor to describe Owner's operational philosophy.
3. Owner will furnish Contractor with names and positions of participants.

C. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.

1. Schedule training with Owner, through Engineer with at least seven days' advance notice.

D. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.

E. Cleanup: Restore systems and equipment to condition existing before initial training use.

END OF SECTION 01 79 00

SECTION 02 41 19 - SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Demolition and removal of selected portions of building or structure.
2. Demolition and removal of selected site elements.
3. Salvage of existing items to be reused or recycled.
4. Protecting existing work to remain.
5. Cleaning soled materials that are to remain.
6. Disconnecting and capping utilities.
7. Removing debris and equipment.
8. Removal of items indicated on Drawings.
9. Salvageable items to be retained by the Owner as indicated on the Drawings and during pre-construction meeting.

B. Related Requirements:

1. Section 01 10 00 – Summary, for restrictions on use of the premises, Owner-occupancy requirements, and phasing requirements.

1.2 DEFINITIONS

A. Remove: Detach items from existing construction and dispose of them off-site unless indicated to be salvaged or reinstalled.

B. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and deliver to Owner ready for reuse.

C. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage, prepare for reuse, and reinstall where indicated.

D. Demolish: To forcefully tear down or take apart a structure.

1.3 MATERIALS OWNERSHIP

A. All ferrous and non-ferrous metals / materials / equipment scheduled for demolition shall be retained by the Owner after demolition and stored in a pre-determined location on-site. All other demolition waste (i.e., Concrete, Asphalt, Etc.) shall be disposed of off-site by the contractor.

B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.

1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.4 PREINSTALLATION MEETINGS

A. Predemolition Conference: Conduct conference at Project site.

1. Inspect and discuss condition of construction to be selectively demolished.
2. Review structural load limitations of existing structure.
3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
5. Review areas where existing construction is to remain and requires protection.

1.5 INFORMATIONAL SUBMITTALS

A. Engineering Survey: Submit engineering survey of condition of building.

B. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and, for noise control. Indicate proposed locations and construction of barriers.

C. Schedule of Selective Demolition Activities: Indicate the following:

1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's on-site operations are uninterrupted.
2. Interruption of utility services. Indicate how long utility services will be interrupted.
3. Coordination for shutoff, capping, and continuation of utility services.
4. Use of elevator and stairs.
5. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.

D. Predemolition Photographs or Video: Show existing conditions of adjoining construction, including finish surfaces that might be misconstrued as damage caused by demolition operations. Submit before Work begins.

E. Warranties: Documentation indicating that existing warranties are still in effect after completion of selective demolition.

1.6 CLOSEOUT SUBMITTALS

A. Inventory: Submit a list of items that have been removed and salvaged.

1.7 QUALITY ASSURANCE

A. Refrigerant Recovery Technician Qualifications: Certified by an EPA-approved certification program.

1.8 FIELD CONDITIONS

A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.

B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

C. Notify Engineer of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.

1. If suspected hazardous materials are encountered, do not disturb; immediately notify Engineer and Owner. Hazardous materials will be removed by Owner under a separate contract.

E. Storage or sale of removed items or materials on-site is not permitted.

F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.

1. Maintain fire-protection facilities in service during selective demolition operations.

1.9 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials and using approved contractors so as not to void existing warranties. Notify warrantor before proceeding.

B. Notify warrantor on completion of selective demolition, and obtain documentation verifying that existing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

1.10 COORDINATION

A. Arrange selective demolition schedule so as not to interfere with Owner's operations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Standards: Comply with ASSE A10.6 and NFPA 241.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting selective demolition operations.

B. Review Project Record Documents of existing construction or other existing condition and hazardous material information provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.

C. Perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.

1. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

D. Steel Tendons: Locate tensioned steel tendons and include recommendations for de-tensioning.

E. Verify that hazardous materials have been remediated before proceeding with building demolition operations.

F. Survey of Existing Conditions: Record existing conditions by use of measured drawings, preconstruction photographs or video and survey/3D scan.
1. Inventory and record the condition of items to be removed and salvaged. Provide photographs or video of conditions that might be misconstrued as damage caused by salvage operations.
2. Before selective demolition or removal of existing building elements that will be reproduced or duplicated in final Work, make permanent record of measurements, materials, and construction details required to make exact reproduction.

3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.

B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished.

1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
2. Arrange to shut off utilities with utility companies.
3. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
4. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated on Drawings to be removed.

a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material and leave in place.
c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material and leave in place.

3.3 PROTECTION

A. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
4. Cover and protect furniture, furnishings, and equipment that have not been removed.
5. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Section 01 50 00 - Temporary Facilities and Controls.

B. Temporary Shoring: Design, provide, and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

1. Strengthen or add new supports when required during progress of selective demolition.

C. Remove temporary barricades and protections where hazards no longer exist.

3.4 SELECTIVE DEMOLITION, GENERAL

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:

1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.

2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
5. Maintain fire watch during and for at least two hours after flame-cutting operations.
6. Maintain adequate ventilation when using cutting torches.
7. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
8. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
9. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
10. Dispose of demolished items and materials promptly.

B. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

C. Work in Historic Areas: Selective demolition may be performed only in areas of Project that are not designated as historic. In historic spaces, areas, and rooms, or on historic surfaces, the terms "demolish" or "remove" shall mean historic "removal" or "dismantling."

D. Removed and Salvaged Items:

1. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers.
3. Store items in a secure area until delivery to Owner.
4. Transport items to Owner's storage area designated by Owner.
5. Protect items from damage during transport and storage.

E. Removed and Reinstalled Items:

1. Clean and repair items to functional condition adequate for intended reuse.
2. Pack or crate items after cleaning and repairing. Identify contents of containers.
3. Protect items from damage during transport and storage.
4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

F. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Engineer, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

3.5 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

A. Concrete: Demolish in small sections. Using power-driven saw, cut concrete to a depth of at least 3/4 inch at junctures with construction to remain. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete. Neatly trim openings to dimensions indicated.

B. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals using power-driven saw, and then remove concrete between saw cuts.

C. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, and then remove masonry between saw cuts.

D. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, and then break up and remove.

3.6 DISPOSAL OF DEMOLISHED MATERIALS

A. Remove demolition waste materials from Project site and dispose of them in an EPA-approved construction and demolition waste landfill acceptable to authorities having jurisdiction and/or recycle or dispose of them.

1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.

B. Burning: Do not burn demolished materials.

3.7 CLEANING

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION 02 41 19

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 03 20 00 – ANCHORAGE IN CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the requirements for cast-in-place, mechanical, and adhesive anchors for concrete.

1.2 RELATED DOCUMENTS:

A. Related work specified elsewhere includes:

1. Section 03 30 00 – Cast-in-Place Concrete.
2. Division 26 – Electrical.
3. Division 43 – Process Gas and Liquid Handling, Purification and Storage Equipment.
4. Division 46 – Water and Wastewater Equipment.

1.3 SUBMITTALS

A. Submit product information to the Engineer for approval in accordance with Section 01 33 00.

PART 2 - PRODUCTS

2.1 WEDGE TYPE ANCHORS

A. Anchors shall feature a stainless-steel split expansion ring; a threaded stud body; and integral cone expander, nut and washer.

B. Anchor bodies smaller than 3/4 inch, excluding countersunk anchors, shall be made from AISI 316 and shall have the following minimum bolt fracture loads:

Anchor Diameter (in.)	Minimum Fracture Load (lb)
1/4	2,900
3/8	7,200
1/2	12,400
5/8	21,900

2.2 Anchor bodies 3/4 inch and larger, and all stainless-steel post nut anchor bodies, shall be made from AISI 316 stainless steel and shall have the following minimum mechanical properties:

Anchor Diameter (in.)	Min. Tensile Strength (ksi)	Min. Yield Strength (ksi)
≤5/8	90	76
≥3/4	76	64

A. All nuts shall meet the dimensional requirements of ASTM F 594.

B. Washers shall meet the dimensional requirements of ANSI B18.22.1, Type A, plain.

C. Expansion sleeve for anchors shall be made from AISI 316. All nuts and washers shall be made from AISI 316.

D. Anchor size and depth shall be as shown on drawings.

E. Manufacturers:

1. Trubolt as manufactured by ITW-Redhead, Inc.; Glenview, IL.
2. Kwik Bolt 3 as manufactured by Hilti, Inc.; Plano, TX.
3. Or Approved Equal.

2.3 ADHESIVE ANCHOR SYSTEM

A. Adhesive anchor system shall consist of an injectable two-part epoxy.

B. Application system shall be in accordance with manufacturer's recommendations. System shall keep the two components separated until application of product directly into drilled hole.

C. System shall thoroughly blend the two parts by means of a static mixer nozzle.

D. Injection adhesive shall be formulated to include resin and hardener to provide optimal curing speed as well as high strength and stiffness.

E. Anchor rods shall be as shown on drawings or as specified in other sections of these specifications.

1. Anchor rods shall be furnished with chamfered ends so that either end will accept a nut and washer.
2. Alternately, anchor rods shall be furnished with a 45° chisel point on one end to allow for easy insertion into the adhesive-filled hole.

F. Nuts and washers shall be provided for anchor rods in the same material as the anchor rod.

G. Manufactures

1. HIT RE 500 Epoxy Adhesive Anchor as manufactured by Hilti, Inc.; Plano, TX.
2. G5 Adhesive Anchoring System as manufactured by ITW-Redhead, Inc.; Glenview, IL.
3. Or Approved Equal.

2.4 CAST-IN-PLACE ANCHORS BOLTS

A. Cast-in-place anchors shall be made of corrosion resistant material in accordance with the dimensions shown on drawings.

1. As a minimum, provide ASTM F1554 Grade 36 steel cast-in-place anchors.
2. If anchor bolt size is not shown on drawings, Contractor shall provide anchors capable of providing four (4) times the load applied to the bolt.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Layout anchors before drilling into concrete to ensure proper placement. Following manufacturer's recommendation for spacing of anchors. Notify Engineer of conflicts between existing conditions and requirements by manufacturer.

B. Install anchors per manufacturer's recommendations.

C. Embedment length shall be per manufacturer's recommendations for load conditions.

D. Check all equipment anchors after equipment has operated. Retighten any loose anchors.

END OF SECTION 03 20 00

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 03 30 00 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes.

B. Related Requirements:

1. Section 03 20 00 – Anchorage in Concrete.
2. Division 31 – Earthwork.

1.2 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.

B. W/C Ratio: The ratio by weight of water to cementitious materials.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:

a. Contractor's superintendent.
b. Independent testing agency responsible for concrete design mixtures.
c. Ready-mix concrete manufacturer.
d. Concrete Subcontractor.
e. Special concrete finish Subcontractor.

2. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, vapor-retarder installation, steel reinforcement installation, methods for achieving specified floor and slab flatness and levelness concrete repair procedures, and concrete protection.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1. Indicate amounts of mixing water to be withheld for later addition at Project site.

C. Steel Reinforcement Shop Drawings: Placing Drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.

D. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.

1. Location of construction joints is subject to approval of the Engineer.

E. Samples: For color finishes, normal weight aggregates, fiber reinforcement, reglets, waterstops, vapor retarder/barrier, and form liners.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and testing agency.

B. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.
2. Admixtures.
3. Form materials and form-release agents.
4. Steel reinforcement and accessories.
5. Waterstops.
6. Curing compounds.
7. Floor and slab treatments.
8. Bonding agents.
9. Adhesives.
10. Vapor retarders.
11. Semi-rigid joint filler.
12. Joint-filler strips.
13. Repair materials.

C. Material Test Reports: From a qualified testing agency.

D. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer. Placing drawings indicating fabrication and erection of forms for specific finished concrete surfaces. Show form construction including jointing, special form joints or reveals, location and pattern of form tie placement, and other items that affect exposed concrete visually.

1. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and reshoring installation and removal.

E. Floor surface flatness and levelness measurements indicating compliance with specified tolerances.

F. Field quality-control reports.

G. Minutes of preinstallation conference.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.

B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94 requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

C. Testing Agency Qualifications: Acceptable to authorities having jurisdiction**,** qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Grade I. Testing agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician, Grade II.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. Avoid damaging coatings on steel reinforcement.

B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

1.8 FIELD CONDITIONS

A. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When average high and low temperature is expected to fall below 40 ºF for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.

2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

B. Hot-Weather Placement: Comply with ACI 301 and as follows:

1. Maintain average concrete temperature below 90 ºF at time of placement. Maximum concrete temperature at time of placement shall be 95 ºF. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 117.
2. ACI 301.
3. ACI 308.
4. ACI 350.

2.2 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

1. Plywood, metal, or other approved panel materials.
2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:

    a. High-density overlay, Class 1 or better.
    b. B-B (Concrete Form), Class 1 or better; mill oiled and edge sealed.

3. Overlaid Finnish birch plywood.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

C. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.

D. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation.

E. Void (Carton) Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.

F. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.

G. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.

H. Form-Release Agent: Commercially formulated (maximum VOC content of 350 mg/L) form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

I. Form Ties: Factory-fabricated, removable or snap-off glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

1. Furnish ties that, when removed, leave holes no larger than 1 inch in diameter in concrete surface.

2.3 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615, Grade 60, deformed.

B. Steel Bar Mats: ASTM A 184, fabricated from ASTM A 615, Grade 60, deformed bars, assembled with clips.

C. Plain-Steel Wire: ASTM A 1064, as drawn.

D. Deformed-Steel Wire: ASTM A 1064.

E. Plain-Steel Welded-Wire Reinforcement: ASTM A 1064, plain, fabricated from as-drawn steel wire into flat sheets.

F. Deformed-Steel Welded-Wire Reinforcement: ASTM A 1064, flat sheet.

G. Galvanized-Steel Welded-Wire Reinforcement: ASTM A 1064, plain, fabricated from galvanized-steel wire into flat sheets.

2.4 REINFORCEMENT ACCESSORIES

A. Joint Dowel Bars: ASTM A 615, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs.

B. Zinc Repair Material: ASTM A 780.

C. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

1. For concrete surfaces exposed to view, where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.
2. For slabs-on-grade, use supports with sand plates or horizontal runners where base material will not support chair legs.

2.5 CONCRETE MATERIALS

A. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.

B. Cementitious Materials:

1. Portland Cement: ASTM C 150, Type I or Type II.

   a. The cement shall be low alkali, less than 0.60 percent. All cement used in concrete that will be in contact with wastewater shall have a tricalcium aluminate ($Ca_3Al_2O_6$) content of less than 8 percent.
   b. Use one brand of cement throughout the Project unless otherwise acceptable to the Engineer.

2. Fly Ash: ASTM C 618, Class F or C.

C. Normal-Weight Aggregates: ASTM C 33, coarse aggregate or better, graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials. Normal weight river gravel and natural sand are acceptable for use as aggregate materials in concrete. All normal weight aggregates shall conform to ASTM C33.

1. Maximum Coarse-Aggregate Size: 1-1/2 inches nominal.

D. Lightweight Aggregate: ASTM C 330, 1-inch-nominal maximum aggregate size.

E. Air-Entraining Admixture: ASTM C 260.

F. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C 494, Type A.
2. Retarding Admixture: ASTM C 494, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017, Type II.

G. Water: ASTM C 94 and potable.

2.6 FIBER REINFORCEMENT

A. Synthetic Micro-Fiber: Monofilament polypropylene micro-fibers engineered and designed for use in concrete, complying with ASTM C 1116, Type III, 1/2 to 1-1/2 inches long.

B. Synthetic Micro-Fiber: Fibrillated polypropylene micro-fibers engineered and designed for use in concrete, complying with ASTM C 1116, Type III, 1/2 to 1-1/2 inches long.

2.7 WATERSTOPS

A. Flexible Rubber Waterstops: CE CRD-C 513, for embedding in concrete to prevent passage of fluids through joints, factory fabricated corners, intersections, and directional changes.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

    a. Sika Greenstreak; Lyndhurst, NJ.
    b. Williams Products, Inc.; Troy, MI.
    c. JP Specialties, Inc.; Murrieta, CA.
    d. Or Approved Equal.

2. Profile: Ribbed with center bulb and/or Ribbed without center bulb.
3. Dimensions: 6 inches by 3/8 inch thick; nontapered.

B. Flexible PVC Waterstops: CE CRD-C 572, for embedding in concrete to prevent passage of fluids through joints, factory fabricated corners, intersections, and directional changes.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. BoMetals, Inc.; Carrolton, GA.
    b. Sika Greenstreak; Lyndhurst, NJ.
    c. JP Specialties, Inc; Murrieta, CA.
    d. Or Approved Equal.

2. Profile: Ribbed with center bulb and/or Ribbed without center bulb.
3. Dimensions: 6 inches by 3/8 inch thick; nontapered.

C. Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 3/4 by 1 inch.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Barrier-Bac; Inteplast Group, Ltd.; Livingston, NJ.
    b. JP Specialties, Inc.; Murrieta, CA.

c. Sika Greenstreak; Lyndhurst, NJ.
d. Or Approved Equal.

D. Self-Expanding Rubber Strip Waterstops: Manufactured rectangular or trapezoidal strip, bentonite-free hydrophilic polymer-modified chloroprene rubber, for adhesive bonding to concrete, 3/8 by 3/4 inch.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Adeka Ultra Seal/OCM, Inc.; Grayslake, IL.
b. Sika Greenstreak; Lyndhurst, NJ.
c. Or Approved Equal.

2.8 VAPOR RETARDERS

A. Sheet Vapor Retarder: Polyethylene sheet, ASTM D 4397, not less than 10 mils thick.

2.9 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. BASF Corporation; Construction Systems; Florham Park, NJ.
b. Euclid Chemical Company (The); an RPM company; Cleveland, OH.
c. Kaufman Products, Inc.; Baltimore, MD.
d. Sika Corporation; Lyndhurst, NJ.
e. SpecChem, LLC.; Kansas City, MO.
f. Or Approved Equal.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. BASF Corporation; Construction Systems; Florham Park, NJ.
b. Euclid Chemical Company (The); an RPM company; Cleveland, OH.
c. W. R. Meadows, Inc.; Hampshire, IL.

d. Or Approved Equal.

F. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, nondissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. BASF Corporation; Construction Systems; Florham Park, NJ.
b. Euclid Chemical Company (The); an RPM company; Cleveland, OH.
c. L&M Construction Chemicals, Inc.; Bethany, CT.
d. TK Products; Minnetonka, MN.
e. Or Approved Equal.

G. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, 18 to 25 percent solids, nondissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. BASF Corporation; Construction Systems; Florham Park, NJ.
b. Dayton Superior; Miamisburg, OH.
c. Euclid Chemical Company (The); an RPM company; Cleveland, OH.
d. L&M Construction Chemicals, Inc.; Bethany, CT.
e. W. R. Meadows, Inc.; Hampshire, IL.
f. Or Approved Equal.

H. Clear, Solvent-Borne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. BASF Corporation; Construction Systems; Florham Park, NJ.
b. Dayton Superior; Miamisburg, OH.
c. Euclid Chemical Company (The); an RPM company; Cleveland, OH.
d. L&M Construction Chemicals, Inc.; Bethany, CT.
e. W. R. Meadows, Inc.; Hampshire, IL.
f. Or Approved Equal.

I. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Dayton Superior; Miamisburg, OH.
b. Euclid Chemical Company (The); an RPM company; Cleveland, OH.
c. L&M Construction Chemicals, Inc.; Bethany, CT.

d. W. R. Meadows, Inc.; Hampshire, IL.
e. Or Approved Equal.

2.10 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.

B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80 according to ASTM D 2240.

C. Bonding Agent: ASTM C 1059, Type II, nonredispersible, acrylic emulsion or styrene butadiene.

D. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:

1. Types I and II, nonload bearing or Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

E. Reglets: Fabricate reglets of not less than 0.022-inch-thick, galvanized-steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.

F. Dovetail Anchor Slots: Hot-dip galvanized-steel sheet, not less than 0.034 inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

2.11 REPAIR MATERIALS

A. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent floor elevations.

1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
4. Compressive Strength: Not less than 5000 psi at 28 days when tested according to ASTM C 109.

2.12 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.

1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

1. Fly Ash: 25 percent.
2. Combined Fly Ash and Pozzolan: 25 percent.
3. Slag Cement: 50 percent.
4. Combined Fly Ash or Pozzolan and Slag Cement: 50 percent portland cement minimum, with fly ash or pozzolan not exceeding 25 percent.
5. Silica Fume: 10 percent.
6. Combined Fly Ash, Pozzolans, and Silica Fume: 35 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.
7. Combined Fly Ash or Pozzolans, Slag Cement, and Silica Fume: 50 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.

C. Limit water-soluble, chloride-ion content in hardened concrete to 0.10 percent by weight of cement.

D. Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water-reducing, high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
2. Use water-reducing and -retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a w/c ratio below 0.50.

2.13 CONCRETE MIXTURES FOR BUILDING ELEMENTS

A. Footings: Normal-weight concrete.

1. Minimum Compressive Strength: -As indicated in Structural General Notes at 28 days.
2. Maximum W/C Ratio: 0.55.
3. Slump Limit: 3 inches. 8 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch.
4. Air Content: 5.5 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch nominal maximum aggregate size.
5. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for 1-inch nominal maximum aggregate size.

B. Foundation Walls: Normal-weight concrete.

1. Minimum Compressive Strength: As indicated in Structural General Notes at 28 days.
2. Maximum W/C Ratio: 0.50

3. Slump Limit: 3 inches. 8 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture plus or minus 1 inch.
4. Air Content: 5.5 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch nominal maximum aggregate size.
5. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for 1-inch nominal maximum aggregate size.

C. Slabs-on-Grade: Normal-weight concrete.

1. Minimum Compressive Strength: As indicated in Structural General Notes at 28 days.
2. Maximum W/C Ratio: 0.50
3. Minimum Cementitious Materials Content: 470 lb/cu. yd.
4. Slump Limit: 3 inches, plus or minus 1 inch.
5. Air Content: 5.5 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch nominal maximum aggregate size.
6. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for 1-inch nominal maximum aggregate size.
7. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.
8. Maximum W/C Ratio: 0.50.

D. Suspended Slabs: Normal-weight concrete.

1. Minimum Compressive Strength: As indicated in Structural General Notes at 28 days.
2. Maximum W/C Ratio: 0.50.
3. Minimum Cementitious Materials Content: 470 lb/cu. yd.
4. Slump Limit: 3 inches, plus or minus 1 inch.
5. Air Content: 4 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch nominal maximum aggregate size.
6. Air Content: 4.5 percent, plus or minus 1.5 percent at point of delivery for 1-inch nominal maximum aggregate size.
7. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.
8. Maximum W/C Ratio: 0.50.

E. Water Retaining Structures.

1. Minimum Compressive Strength: As indicated in Structural General Notes at 28 days.
2. Maximum W/C Ratio: 0.45.
3. Minimum Cementitious Materials Content: 535 lb/cu. yd.
4. Slump Limit: 4 inches, plus or minus 1 inch.
5. Air Content: 4.5 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch nominal maximum aggregate size.
6. Air Content: 4.5 percent, plus or minus 1.5 percent at point of delivery for 1-inch nominal maximum aggregate size.

F. Concrete Toppings: Normal-weight concrete.

1. Minimum Compressive Strength: As indicated in Structural General Notes at 28 days.
2. Minimum Cementitious Materials Content: 600 lb/cu. yd.
3. Slump Limit: 3 inches, plus or minus 1 inch.

4. Air Content: 5.5 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch nominal maximum aggregate size.
5. Air Content: Do not allow air content of trowel-finished toppings to exceed 3 percent.
6. Steel-Fiber Reinforcement: Add to concrete mixture, according to manufacturer's written instructions, at a rate of 50 lb/cu. yd.
7. Synthetic Micro-Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of 1.5 lb/cu. yd.

G. Building Frame Members: Normal-weight concrete.

1. Minimum Compressive Strength: As indicated in Structural General Notes at 28 days.
2. Maximum W/C Ratio: 0.50.
3. Slump Limit: 4 inches. 8 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch.
4. Air Content: 4.5 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch nominal maximum aggregate size.

H. Building Walls: Normal-weight concrete.

1. Minimum Compressive Strength: As indicated in Structural General Notes at 28 days.
2. Maximum W/C Ratio: 0.50.
3. Slump Limit: 4 inches. 8 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch.
4. Air Content: 5.5 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch nominal maximum aggregate size.

2.14 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.15 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94 and ASTM C 1116, and furnish batch ticket information.

1. When air temperature is between 85 and 90 ºF, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 ºF, reduce mixing and delivery time to 60 minutes.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For mixer capacity of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
2. For mixer capacity larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd.

3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 - EXECUTION

3.1 FORMWORK INSTALLATION

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

C. Limit concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:

1. Class A, 1/8 inch for smooth-formed finished surfaces.
2. Class B, 1/4 inch for rough-formed finished surfaces.

D. Construct forms tight enough to prevent loss of concrete mortar.

E. Construct forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast-concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.

1. Install keyways, reglets, recesses, and the like, for easy removal.
2. Do not use rust-stained steel form-facing material.

F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.

G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

H. Chamfer exterior corners and edges of permanently exposed concrete.

I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 EMBEDDED ITEM INSTALLATION

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303.

3.3 REMOVING AND REUSING FORMS

A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 ºF for 48 hours after placing concrete with a 72 hour pour back for adjacent pours. Concrete has to be hard enough to not be damaged by form-removal operations, and curing and protection operations need to be maintained.

1. Leave formwork for beam soffits, joists, slabs, and other structural elements that support weight of concrete in place until concrete has achieved at least 70 percent of its 28-day design compressive strength.
2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.

B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material are not acceptable for exposed surfaces. Apply new form-release agent.

C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Engineer.

3.4 SHORING AND RESHORING INSTALLATION

A. Comply with ACI 318 and ACI 301 for design, installation, and removal of shoring and reshoring.

1. Do not remove shoring or reshoring until measurement of slab tolerances is complete.

B. In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.

C. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

3.5 VAPOR-RETARDER INSTALLATION

A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E 1643 and manufacturer's written instructions.

1. Lap joints 6 inches and seal with manufacturer's recommended tape.

B. Bituminous Vapor Retarders: Place, protect, and repair bituminous vapor retarder according to manufacturer's written instructions.

3.6 STEEL REINFORCEMENT INSTALLATION

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

E. Install welded-wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

3.7 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Engineer.

1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.

5. Space vertical joints in walls as indicated on Contractor's submitted and approved construction joint layout. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
6. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into concrete as soon as cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated.
2. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

E. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.8 WATERSTOP INSTALLATION

A. Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of the Work. Field fabricated joints in waterstops according to manufacturer's written instructions.

3.9 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections are completed.

B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Engineer.

C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.

1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.

1. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
2. Maintain reinforcement in position on chairs during concrete placement.
3. Screed slab surfaces with a straightedge and strike off to correct elevations.
4. Slope surfaces uniformly to drains where required.
5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

3.10 FINISHING FORMED SURFACES

A. Rough-Formed Finish: Provide a rough-formed finish on formed concrete surfaces not exposed to view in the finished Work or concealed by other construction. This is the concrete surface having texture imparted by form-facing material used, with tie holes and defective areas repaired and patched, and fins and other projections exceeding 1/4 inch in height rubbed down or chipped off.

B. Smooth-Formed Finish: Provide a smooth-formed finish on formed concrete surfaces exposed to view or to be covered with a coating material applied directly to concrete, or a covering material applied directly to concrete, such as waterproofing, dampproofing, veneer plaster, painting, or another similar system. This is an as-cast concrete surface obtained with selected form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch defective areas with fins and other projections completely removed and smoothed.

C. Smooth Rubbed Finish: Apply the following to smooth-formed-finished as-cast concrete where indicated:

1. Perform no later than one day after form removal.

2. Moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture.
3. If sufficient cement paste cannot be drawn from the concrete by the rubbing process, use a grout made from the same cementitious materials used in the in-place concrete.
4. Smooth-Rubbed Finish: Apply to the top of exposed concrete walls and the outside exposed face to 1' below grade on all new concrete structures and new concrete additions.

D. Grout Cleaned Finish: Provide grout-cleaned finish on scheduled concrete surfaces that have received smooth-formed finish treatment.

1. Combine 1 part Portland cement to 1-1/2 parts fine sand by volume, complying with ASTM C144 or ASTM C404, and a 50:50 mixture of acrylic or styrene butadiene-based bonding admixture and water to form the consistency of thick paint. Blend standard Portland cement and white Portland cement in amounts determined by trial patches so that final color of dry grout will match adjacent surfaces.
2. Thoroughly wet concrete surfaces, apply grout to coat surfaces, and fill small holes. Remove excess grout by scraping and rubbing with clean burlap. Keep damp by fog spray for at least 36 hours after rubbing.

E. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.11 FINISHING FLOORS AND SLABS

A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Scratch Finish: Apply scratch finish to monolithic slab surfaces to receive concrete floor topping or mortar setting beds for tile, Portland cement terrazzo, and other bonded applied cementitious finish flooring material, and where indicated.

1. After placing slabs, finish surface to tolerances of F(F) 15 (floor flatness) and F(L) 13 (floor levelness) measured according to ASTM E 1155. Slope surfaces uniformly to drains where required. After leveling, roughen surface before final set with stiff brushes, brooms, or rakes.

C. Float Finish: Apply float finish to monolithic slab surfaces to receive trowel finish and other finishes as specified; slab surfaces to be covered with membrane or elastic waterproofing, membrane or elastic roofing, or sand-bed terrazzo; and where indicated.

1. After screeding, consolidating, and leveling concrete slabs, do not work surface until ready for floating. Begin floating, using float blades or float shoes only, when surface water has disappeared, or when concrete has stiffened sufficiently to permit operation of power-driven floats, or both. Consolidate surface with power-driven floats or by hand-floating if area is small or inaccessible to power units. Finish surfaces to tolerances of F(F) 18 (floor flatness) and F(L) 15 (floor levelness) measured according to ASTM E 1155. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to a uniform, smooth, granular texture.

D. Trowel Finish: Apply a trowel finish to monolithic slab surfaces exposed to view and slab surfaces to be covered with resilient flooring, carpet, ceramic or quarry tile, paint, or another thin film-finish coating system.

1. After floating, begin first trowel-finish operation using a power-driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over surface. Consolidate concrete surface by final hand-troweling operation, free of trowel marks, uniform in texture and appearance, and finish surfaces to tolerances of F(F) 20 (floor flatness) and F(L) 17 (floor levelness) measured according to ASTM E 1155. Grind smooth any surface defects that would telegraph through applied floor covering system.

E. Trowel and Fine Broom Finish: Where ceramic or quarry tile is to be installed with thin-set mortar, apply a trowel finish as specified, then immediately follow by slightly scarifying the surface with a fine broom.

F. Nonslip Broom Finish: Apply a nonslip broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.

1. Immediately after float finishing, slightly roughen concrete surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Engineer before application.

G. Nonslip Aggregate Finish: Apply nonslip aggregate finish to concrete stair treads, platforms, ramps, sloped walks, and where indicated.

1. After completing float finishing and before starting trowel finish, uniformly spread 25 lb of dampened nonslip aggregate per 100 sq. ft. of surface. Tamp aggregate flush with surface using a steel trowel, but do not force below surface. After broadcasting and tamping, apply trowel finishing as specified.
2. After curing, lightly work surface with a steel wire brush or an abrasive stone, and water to expose nonslip aggregate.

3.12 MISCELLANEOUS CONCRETE ITEM INSTALLATION

A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations:

1. Coordinate sizes and locations of concrete bases with actual equipment provided.
2. Construct concrete bases 6 inches high unless otherwise indicated, and extend base not less than 6 inches in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated or unless required for seismic anchor support.
3. Minimum Compressive Strength: 4000 psi at 28 days.

4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete substrate.
6. Prior to pouring concrete, place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
7. Cast anchor-bolt insert into bases. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel finish concrete surfaces.

3.13 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 301 and ACI 306.1 for cold-weather protection and ACI 301 and ACI 305.1 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for remainder of curing period.

D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.

E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:

1. Moisture Curing: Required for all water retaining structures. Keep surfaces continuously moist for not less than seven days with the following materials:

    a. Water.
    b. Continuous water-fog spray.
    c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period, using cover material and waterproof tape.

    a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.

b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies does not interfere with bonding of floor covering used on Project.

3. Curing Compound: For non-liquid retaining structures and floors only. Comply with ASTM C171. Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

   a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies in writing that the curing compound does not interfere with bonding of floor covering used on Project.

4. Curing and Sealing Compound: For non-liquid retaining structures and floors only. Comply with ASTM C171. Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.14 JOINT FILLING

A. Prepare, clean, and install joint filler according to manufacturer's written instructions.

   1. Defer joint filling until concrete has aged at least three (3) month(s). Do not fill joints until construction traffic has permanently ceased.

B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joints clean and dry.

C. Install semi-rigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.15 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Engineer. Remove and replace concrete that cannot be repaired and patched to Engineer's approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of 1 part Portland cement to 2-1/2 parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete. Limit cut depth to 3/4 inch. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
2. Repair defects on surfaces exposed to view by blending white Portland cement and standard Portland cement so that, when dry, patching mortar matches surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Engineer.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
2. After concrete has cured at least 14 days, correct high areas by grinding.
3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
5. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete, except without coarse aggregate. Place, compact, and finish blending with adjacent finished concrete. Cure in same manner as adjacent concrete.
6. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to Engineer’s approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to Engineer’s approval.

3.16 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a–qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

C. Inspections:

1. Steel reinforcement placement.
2. Steel reinforcement welding.
3. Headed bolts and studs.
4. Concrete placement, including conveying and depositing.
5. Curing procedures and maintenance of curing temperature.

D. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.

    a. When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C 143; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C 231, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 ºF and below or 80 ºF and above, and one test for each composite sample.
5. Compression Test Specimens: ASTM C 31.

    a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.
    b. Cast and field cure two sets of two standard cylinder specimens for each composite sample.

6. Compressive-Strength Tests: ASTM C 39; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.

    a. Test one set of two field-cured specimens at 7 days and one set of two specimens at 28 days.
    b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.

7. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
8. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
9. Test results shall be reported in writing to Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
10. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer but will not be used as sole basis for approval or rejection of concrete.
11. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Engineer. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42 or by other methods as directed by Engineer.
12. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
13. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

E. Measure floor and slab flatness and levelness according to ASTM E 1155 within 24 hours of finishing for laboratory and office buildings.

F. For floors required for sloping, the slope must be within 1/16” tolerances of that required in the plans.

3.17 PROTECTION OF LIQUID FLOOR TREATMENTS

A. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.

3.18 WET TESTING

A. General

1. All new, water-retaining concrete structures shall be tested for water-tightness by the testing procedure described below and in accordance with ACI 350.1.
2. All testing work shall be performed by the Contractor in the presence of the Engineer. The Engineer shall be notified at least five (5) days in advance of the time at which testing will be performed.

B. Testing Water

1. Water for wet testing shall be furnished by the Contractor. The source of the water must be approved by the Engineer prior to filling of the structure. As a general rule, plant effluent water is acceptable for use as testing water; however, this must be confirmed by the Engineer.
2. Once testing is complete, testing water shall be disposed of in a manner acceptable to the Engineer and, unless otherwise permitted by the Engineer, shall not be allowed to enter other parts of the system.

C. Test Equipment

1. All temporary equipment needed for wet testing must be provided by the Contractor (e.g. connections between the structure to be tested and the water source, pumping equipment, metering devices, pressure or vacuum gauges, temporary flanges, valves, bulkheads, bracing, blocking, and other equipment that may be necessary to perform the testing).
2. All temporary equipment shall be removed upon satisfactory completion of wet testing.

D. Test Preparation

1. Unless otherwise specified, wet testing shall be performed after installation of pipe sleeves and before placement of backfill, cleaning, disinfection, installation of process equipment, or any other activities that would hinder visual inspection of the structure during the test.
2. Exposed concrete surfaces of the structure (including the floor) shall be cleaned of all foreign material and debris prior to the test. Standing water in or outside the structure that would interfere with the observation of the exposed concrete surfaces of the structure shall be removed. The concrete surfaces and concrete joints shall be thoroughly inspected for potential points of leakage, and those areas shall be repaired prior to filling the structure with water.
3. Adjacent structures having common walls shall be tested individually at different times to allow examination of the dividing walls for leaks.
4. Pipe connections or openings to structures, if not provided with drip tight valves, shall be temporarily plugged during testing. Where slide gates, sluice gates or similar devices are located, the Contractor shall provide bulkheads or the means to make them drip tight, and shall measure any leakage.
5. Filling of the structure shall not begin before the designed compressive strength of all concrete elements of the structure has been reached or before fourteen (14) days after all concrete walls or base slabs have been placed.

E. Test Procedure

1. Soaking Period: Fill the unlined concrete structure to 1 foot above the maximum operating water surface level and maintain that water level for a minimum of 72 hours, to minimize absorption of water into the concrete during testing. Identify and repair all visible leaks during the soaking period.
2. Testing Period: At the end of this soaking period, once all leaks have been repaired and the water level brought back to the required elevation, the testing period shall begin. Mark the water level with a weight suspended from a string and measure its elevation with a surveyor’s level. Allow the structure to sit for a minimum of 48 hours. Following this period, identify and repair all visible leaks. Record and submit to the Engineer measurements of the water level at the beginning and end of the testing period.

3. Evaporation/Precipitation: During the testing period, suspend a bucket or pan in the structure and fill it halfway with testing water. Record and submit to the Engineer measurements of the water level at the beginning and end of the testing period, for use in accounting for any evaporation and precipitation that may have occurred during testing.

F. Leakage

1. Leakage requiring repair shall be defined as any moisture on the exterior surface of the structure, ranging from damp spots to dripping or trickling to shooting streams of water. All visible leakage is to be repaired even if magnitude is within allowable leakage.
2. Allowable leakage: For unlined tanks with a side-water depth of 25 feet or less, the net loss of water volume (including evaporation/precipitation) shall not exceed 0.1 percent in 24 hours.

G. Test Conclusion

1. If the leakage observed during testing (including evaporation/precipitation) is less than the allowable leakage, the structure shall be considered sufficiently water-tight. If it is greater than the allowable, the structure shall be drained, necessary repairs shall be made, and the structure shall be re-tested.

END OF SECTION 03 30 00

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 03 60 00 - GROUTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Portland cement grout.
2. Rapid-curing epoxy grout.
3. Nonshrink cementitious grout.

B. Related Requirements:

1. Section 03 30 00 - Cast-in-Place Concrete: Cast-in-place or in-situ concrete for structural building frames, slabs on fill or grade, and other concrete components.

1.2 REFERENCE STANDARDS

A. American Concrete Institute:

1. ACI 301 - Specifications for Structural Concrete for Buildings.
2. ACI 318 - Building Code Requirements for Structural Concrete.
3. ACI 350 – Code Requirements for Environmental Engineering Concrete Structures.

B. ASTM International:

1. ASTM C33 - Standard Specification for Concrete Aggregates.
2. ASTM C40 - Standard Test Method for Organic Impurities in Fine Aggregates for Concrete.
3. ASTM C150 - Standard Specification for Portland Cement.
4. ASTM C191 - Standard Test Methods for Time of Setting of Hydraulic Cement by Vicat Needle.
5. ASTM C307 - Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacings.
6. ASTM C531 - Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
7. ASTM C579 - Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
8. ASTM C827 - Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures.

C. U. S. Army Corps of Engineers Concrete Research Division (CRD):

1. CRD-C621 - Non-Shrink Grout.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer information regarding grout.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Manufacturer Instructions: Submit instructions for mixing, handling, surface preparation, and placing epoxy-type and nonshrink grouts.

E. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store materials according to manufacturer instructions.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.5 AMBIENT CONDITIONS

A. Section 01 50 00 - Temporary Facilities and Controls: Requirements for ambient condition control facilities for product storage and installation.

B. Maximum Conditions: Do not perform grouting if temperatures exceed manufacturer’s recommendations.

C. Minimum Conditions: Maintain minimum temperature per the manufacturer before, during, and after grouting, until grout has set.

PART 2 - PRODUCTS

2.1 PORTLAND CEMENT GROUT

A. Portland Cement: Comply with ASTM C150, Type I and II.

B. Water:

1. Potable.
2. No impurities, suspended particles, algae, or dissolved natural salts in quantities capable of causing:

    a. Corrosion of steel.
    b. Volume change increasing shrinkage cracking.
    c. Efflorescence.
    d. Excess air entraining.

C. Fine Aggregate:

1. Washed natural sand.
2. Gradation:

    a. Comply with ASTM C33.
    b. Represented by smooth granulometric curve within required limits.

3. Free from injurious amounts of organic impurities according to ASTM C40.

D. Mix:

1. Portland cement, sand, and water.
2. Do not use ferrous aggregate or staining ingredients in grout mixes.

2.2 RAPID-CURING EPOXY GROUT

A. Manufacturers:

1. L&M Construction Chemicals; Bethany, CT.
2. Sika Corporation; Lyndhurst, NJ.
3. WR Meadows; Hampshire, IL.
4. Or Approved Equal.

B. Description:

1. High-strength, three-component epoxy grout formulated with thermosetting resins and inert fillers.
2. Rapid-curing, high adhesion, and resistant to ordinary chemicals, acids, and alkalis.

C. Performance and Design Criteria:

1. Compressive Strength:

    a. 12,000 psi at seven days.
    b. Comply with ASTM C579.

2. Minimum Tensile Strength:

    a. 2,000 psi.
    b. Comply with ASTM C307.

3. Coefficient of Expansion:

    a. 30x10-6 inch per degree F.
    b. Comply with ASTM C531.

4. Shrinkage:

    a. None.
    b. Comply with ASTM C827.

2.3 NONSHRINK CEMENTITIOUS GROUT

A. Manufacturers:

1. Euclid Chemical Company; Cleveland, OH.
2. Sika Corporation; Lyndhurst, NJ.
3. L&M Construction Chemicals; Bethany, CT.
4. Or Approved Equal.

B. Description:

1. Pre-mixed and ready-for-use formulation requiring only addition of water.
2. Nonshrink, non-corrosive, nonmetallic, non-gas forming, and no chlorides.

C. Performance and Design Criteria:

1. Certified to maintain initial placement volume or expand after set, and to meet following minimum properties when tested according to CRD-C621 for Type D nonshrink grout:

    a. Setting Time:

        1) Initial: Approximately 2 hours.
        2) Final: Approximately 3 hours.
        3) Comply with ASTM C191.

    b. Maximum Expansion: 0.10 to 0.40 percent.
    c. Compressive Strength:

        1) One-Day: 4,000 psi.
        2) Seven-Day: 7,000 psi.
        3) 28-Day: 10,000 to 10,800 psi.
        4) Comply with CRD-C621.

2.4 FORMWORK

A. As specified in Section 03 30 00 – Cast-In-Place Concrete.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify areas to receive grout.

3.2 PREPARATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.

B. Remove defective concrete, laitance, dirt, oil, grease, and other foreign material from concrete surfaces by brushing, hammering, chipping, or other similar means until sound and clean concrete surface is achieved.

C. Roughen concrete lightly, but not to interfere with placement of grout.

D. Remove foreign materials from metal surfaces in contact with grout.

E. Align, level, and maintain final positioning of components to be grouted.

F. Saturate concrete surfaces with clean water, and then remove excess water.

3.3 INSTALLATION

A. Formwork:

1. Construct leak proof forms anchored and shored to withstand grout pressures.
2. Install formwork with clearances to permit proper placement of grout.
3. As specified in Section 03 30 00 – Cast-In-Place Concrete.

B. Mixing:

1. Portland Cement Grout:

a. Use proportions of two parts sand and one part cement, measured by volume.
b. Prepare grout with water to obtain consistency to permit placing and packing.
c. Mix water and grout in two steps:

1) Pre-mix using approximately 2/3 of water.
2) After partial mixing, add remaining water to bring mix to desired placement consistency and continue mixing two to three minutes.

d. Mix only quantities of grout capable of being placed within 30 minutes after mixing.
e. Do not add additional water after grout has been mixed.

f. Minimum Compressive Strength: 2,400 psi in 48 hours and 7,000 psi in 28 days.

2. Rapid-Curing Epoxy Grout:

a. Mix and prepare according to manufacturer instructions.
b. Minimum Compressive Strength: 2,400 psi in 48 hours and 7,000 psi in 28 days.

3. Nonshrink Cementitious Grout:

a. Mix and prepare according to manufacturer instructions.
b. Minimum Compressive Strength: 2,400 psi in 48 hours and 7,000 psi in 28 days.

4. Mix grout components in proximity to Work area and transport mixture quickly and in manner not permitting segregation of materials.

C. Placing of Grout:

1. Place grout material quickly and continuously.
2. Do not use pneumatic-pressure or dry-packing methods.
3. Apply grout from one side only to avoid entrapping air.
4. Do not vibrate placed grout mixture or permit placement if area is being vibrated by nearby equipment.
5. Thoroughly compact final installation and eliminate air pockets.
6. Do not remove leveling shims for at least 48 hours after grout has been placed.

D. Curing:

1. Prevent rapid loss of water from grout during first 48 hours by use of approved membrane curing compound or by using wet burlap method.
2. Immediately after placement, protect grout from premature drying, excessively hot or cold temperatures, and mechanical injury.
3. After grout has attained its initial set, keep damp for minimum three (3) days.

3.4 FIELD QUALITY CONTROL

A. Inspection and Testing:

1. Comply with ACI 301 and as specified in Section.
2. Submit proposed mix design of each class of grout to Engineer for review prior to commencement of Work.
3. Tests of grout components may be performed to ensure compliance with specified requirements.

END OF SECTION 03 60 00

SECTION 05 40 00 - ALUMINUM HANDRAIL

PART 1 - GENERAL

1.1 SCOPE

A. The work covered by this section includes furnishing all labor, equipment and materials required to furnish and install aluminum component handrail including all fittings, anchors, bases and accessories, as required by the Contract Documents.

B. All guardrails shall be furnished with a toe board, except where concrete curbs are shown (if any).

C. This section shall be used for all handrail except in areas where stairs and handrail are congruent as specified in Section 05 52 13.

1.2 RELATED DOCUMENTS

A. Related work specified elsewhere includes:

1. Section 03 20 00 – Anchorage in Concrete.
2. Section 03 30 00 – Cast-in-Place Concrete.
3. Section 05 50 00 – Metal Fabrications.
4. Section 05 52 13 – Pipe and Tube Railings
5. Section 09 96 00 – High Performance Coatings

1.3 SUBMITTALS

A. Submit complete shop drawings and product data in accordance with the requirements of Section 01 33 00 – Submittal Procedures.

B. Submit structural calculations, including anchorages.

1.4 STORAGE AND PROTECTION

A. Handrails shall be properly packaged to prevent scratching and denting during shipment, storage and erection. Maintain protective wrapping until project is completed.

PART 2 - PRODUCTS

2.1 DESIGN REQUIREMENTS

A. Component aluminum handrail system shall be designed and constructed in strict compliance with the requirements of OSHA and the International Building Code.

B. Guardrails shall be designed to withstand a uniform horizontal load of 50 pounds per foot with a simultaneous vertical load of 100 pounds per foot applied to the top rail.

C. Handrail shall be designed to withstand a uniform horizontal load of 50 pounds per foot applied to the top rail.

D. In addition, guardrails, handrails shall be designed to withstand a concentrated load of 200 pounds applied in any direction, at any point on the railing system.

2.2 ACCEPTABLE PRODUCTS/MANUFACTURERS

A. Component aluminum handrail system shall be

1. "TUFrail" by Thompson Fabricating; Birmingham, AL.
2. "Interna-Rail" by Hollaender Corp.; Cincinnati, OH.
3. Alumagard; Denver, CO.
4. Or Approved Equal.

2.3 MATERIAL AND CONSTRUCTION

A. Handrail shall be the product of a company normally engaged in the manufacture of pipe railing. Railing shall be shop assembled in lengths not to exceed 24 feet for field erection.

B. Post spacing shall be a maximum of 6'-0". Posts and rails shall be a minimum of 1 1/2" schedule 40 aluminum pipe, alloy 6063-T6 or 6105-T5, ASTM B-429 or B-221.

C. Handrail shall be made of pipe and fittings mechanically fastened together with stainless steel hardware. Handrail systems which use fittings that are glued or pop-riveted will not be acceptable.

D. Toe board shall conform to OSHA standards. Toe board shall be a minimum of 4" high and shall attach to the post using clamps which will allow for expansion and contraction between posts. Toe board shall be set 1/4" above the walking surface.

E. Wedge anchors shall be spaced 10d apart and 5d edge distance for no reduction in pullout strength. A safety factor of 4 shall be used on pullout values published by the manufacturer. Wedge anchors shall be type 304 stainless steel.

F. Openings in the railing shall guarded by a self-closing gate (OSHA 1910.23). Safety chains are not acceptable.

G. All handrail and components shall be clear anodized per Aluminum Association M10C22A41 (215-R1). The pipe shall be plastic wrapped to protect the finish.

H. All aluminum surfaces in contact with concrete, grout or dissimilar metals shall be protected with a coat of bituminous paint, mylar isolators or other approved material.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Field fabrication of the railing system is not permitted.

B. Set handrails plumb within 1/8" of vertical and align horizontally to within 1/8" in 12 feet.

C. Install wedge anchors to proper depth to develop full pullout and shear values. Check all fasteners and bolts in base connections and splices for tightness.

D. Adequate provisions for expansion and contraction shall be incorporated into the rail. Expansion joints shall be placed at 60-foot intervals and at all concrete expansion joints.

E. Toe boards shall be shipped loose and attached to the handrail in the field. Attachment to the posts shall be made with clamps which will allow for expansion and contraction while maintaining a straight line.

F. All defective, damaged or otherwise improperly installed handrail shall be removed and replaced with material which complies with this section at no additional cost to the Owner.

G. Following installation, aluminum handrail shall be cleaned with a mild soap and clean water. Acid solutions, steel wool or harsh abrasives shall not be used.

END OF SECTION 05 40 00

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 05 50 00 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel framing and supports for overhead doors.
2. Steel framing and supports for mechanical and electrical equipment.
3. Steel framing and supports for applications where framing and supports are not specified in other Sections.
4. Shelf angles.
5. Alternating tread devices.
6. Ships' ladders.
7. Metal floor plate and supports.
8. Metal bollards.
9. Metal downspout boots.
10. Loose bearing and leveling plates for applications where they are not specified in other Sections.
11. Loose steel lintels.

B. Products furnished, but not installed, under this Section include the following:

1. Loose steel lintels.
2. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
3. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.

C. Related Requirements:

1. Section 03 30 00 – Cast-in-Place Concrete for installing anchor bolts, steel pipe sleeves, slotted-channel inserts, wedge-type inserts, and other items cast into concrete.

1.2 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of metal fabrications that are anchored to or that receive other work. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Nonslip aggregates and nonslip-aggregate surface finishes.
2. Prefabricated building columns.
3. Metal nosings and treads.
4. Paint products.
5. Grout.

B. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide Shop Drawings for the following:

1. Steel framing and supports for overhead doors
2. Steel framing and supports for mechanical and electrical equipment.
3. Steel framing and supports for applications where framing and supports are not specified in other Sections.
4. Alternating tread devices.
5. Metal floor plate and supports.
6. Ships' ladders.
7. Miscellaneous steel trim.
8. Metal bollards.
9. Downspout guards.
10. Abrasive metal nosings treads and thresholds.
11. Metal downspout boots.
12. Loose steel lintels.

C. Samples for Verification: For each type and finish of extruded nosing and tread.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer.

B. Mill Certificates: Signed by stainless-steel manufacturers, certifying that products furnished comply with requirements.

C. Welding certificates.

D. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

E. Research/Evaluation Reports: For post-installed anchors, from ICC-ES.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code - Steel."

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code - Steel."
2. AWS D1.2, "Structural Welding Code - Aluminum."
3. AWS D1.6, "Structural Welding Code - Stainless Steel."

1.6 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 - Quality Requirements, to design ladders.

B. Structural Performance of Aluminum Ladders: Aluminum ladders, including landings, shall withstand the effects of loads and stresses within limits and under conditions specified in ANSI A14.3.

C. Structural Performance of Alternating Tread Devices: Alternating tread devices shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.

1. Uniform Load: 100 lbf/sq. ft.
2. Concentrated Load: 300 lbf applied on an area of 4 sq. in.
3. Uniform and concentrated loads need not be assumed to act concurrently.
4. Alternating Tread Device Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.

1. Temperature Change: 120 ºF, ambient; 180 ºF, material surfaces.

2.2 METALS

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Steel Plates, Shapes, and Bars: ASTM A 36.

C. Stainless-Steel Sheet, Strip, and Plate: ASTM A 240 or ASTM A 666, Type 316L.

D. Stainless-Steel Bars and Shapes: ASTM A 276, Type 316L.

E. Rolled-Steel Floor Plate: ASTM A 786, rolled from plate complying with ASTM A 36 or ASTM A 283, Grade C or D.

F. Rolled-Stainless-Steel Floor Plate: ASTM A 793.

G. Steel Tubing: ASTM A 500, cold-formed steel tubing.

H. Steel Pipe: ASTM A 53, Standard Weight (Schedule 40) unless otherwise indicated.

I. Zinc-Coated Steel Wire Rope: ASTM A 741.

1. Wire-Rope Fittings: Hot-dip galvanized-steel connectors with capability to sustain, without failure, a load equal to minimum breaking strength of wire rope with which they are used.

J. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.

1. Size of Channels: As indicated.
2. Material: Galvanized steel, ASTM A 653, structural steel, Grade 33, with G90 coating; 0.079-inch nominal thickness.
3. Material: Cold-rolled steel, ASTM A 1008, structural steel, Grade 33; 0.0677-inch minimum thickness; hot-dip galvanized after fabrication.

K. Cast Iron: Either gray iron, ASTM A 48, or malleable iron, ASTM A 47, unless otherwise indicated.

L. Aluminum Plate and Sheet: ASTM B 209, Alloy 6061-T6.

M. Aluminum Extrusions: ASTM B 221, Alloy 6063-T6.

N. Aluminum-Alloy Rolled Tread Plate: ASTM B 632, Alloy 6061-T6.

O. Aluminum Castings: ASTM B 26, Alloy 443.0-F.

P. Bronze Extrusions: ASTM B 455, Alloy UNS No. C38500 (extruded architectural bronze).

Q. Bronze Castings: ASTM B 584, Alloy UNS No. C83600 (leaded red brass) or No. C84400 (leaded semired brass).

R. Nickel Silver Extrusions: ASTM B 151, Alloy UNS No. C74500.

S. Nickel Silver Castings: ASTM B 584, Alloy UNS No. C97600 (20 percent leaded nickel bronze).

2.3 FASTENERS

A. General: Unless otherwise indicated, provide Type 316 stainless-steel fasteners for exterior use and use in wastewater treatment facilities. Use Zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

1. Provide stainless-steel fasteners for fastening aluminum.
2. Provide stainless-steel fasteners for fastening stainless steel.
3. Provide stainless-steel fasteners for fastening nickel silver.
4. Provide bronze fasteners for fastening bronze.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.

C. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 325, Type 3; with hex nuts, ASTM A 563, Grade C3; and, where indicated, flat washers.

D. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, ASTM F 593; with hex nuts, ASTM F 594; and, where indicated, flat washers; Alloy Group 2.

E. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563; and, where indicated, flat washers.

1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.

F. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

G. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47 malleable iron or ASTM A 27 cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F 2329.

H. Post-Installed Anchors: Torque-controlled expansion anchors.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 2 stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594.

I. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, 1-5/8 by 7/8 inches by length indicated with anchor straps or studs not less than 3 inches long at not more than 8 inches o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B 633, Class Fe/Zn 5, as needed for fastening to inserts.

2.4 MISCELLANEOUS MATERIALS

A. Shop Primers: Provide primers that comply with manufacturer’s recommendations in Section 09 96 00 – High Performance Coatings.

B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

C. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.

D. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

F. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

G. Concrete: Comply with requirements in Section 03 30 00 - Cast-in-Place Concrete for normal-weight, air-entrained, concrete with a minimum 28-day compressive strength of 3000 psi.

2.5 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

J. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches, with a minimum 6-inch embedment and 2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

2.6 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

1. Fabricate units from slotted channel framing where indicated.
2. Furnish inserts for units installed after concrete is placed.

C. Fabricate supports for operable partitions from continuous steel beams of sizes indicated with attached bearing plates, anchors, and braces as indicated. Drill or punch bottom flanges of beams to receive partition track hanger rods; locate holes where indicated on operable partition Shop Drawings.

D. Fabricate steel girders for wood frame construction from continuous steel shapes of sizes indicated.

1. Provide bearing plates welded to beams where indicated.
2. Drill or punch girders and plates for field-bolted connections where indicated.
3. Where wood nailers are attached to girders with bolts or lag screws, drill or punch holes at 24 inches o.c.

E. Fabricate steel pipe columns for supporting wood frame construction from steel pipe with steel baseplates and top plates as indicated. Drill or punch baseplates and top plates for anchor and connection bolts and weld to pipe with fillet welds all around. Make welds the same size as pipe wall thickness unless otherwise indicated.

1. Unless otherwise indicated, fabricate from Schedule 40 steel pipe.
2. Unless otherwise indicated, provide 1/2-inch baseplates with four 5/8-inch anchor bolts and 1/4-inch top plates.

F. Galvanize miscellaneous framing and supports where indicated.

G. Prime miscellaneous framing and supports with zinc-rich primer.

2.7 SHELF ANGLES

A. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4-inch bolts, spaced not more than 6 inches from ends and 24 inches o.c., unless otherwise indicated.

1. Provide mitered and welded units at corners.
2. Provide open joints in shelf angles at expansion and control joints. Make open joint approximately 2 inches larger than expansion or control joint.

B. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete.

C. Galvanize shelf angles located in exterior walls.

2.8 METAL LADDERS

A. General:

1. Comply with ANSI A14.3.
2. For elevator pit ladders, comply with ASME A17.1/CSA B44.

B. Steel Ladders:

1. Space siderails 18 inches apart unless otherwise indicated.
2. Siderails: Continuous, 3/8-by-2-1/2-inch steel flat bars, with eased edges.
3. Rungs: 1-inch-diameter or 1-inch-square steel bars.
4. Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.
5. Provide nonslip surfaces on top of each rung, either by coating rung with aluminum-oxide granules set in epoxy-resin adhesive or by using a type of manufactured rung filled with aluminum-oxide grout.
6. Provide platforms as indicated fabricated from welded or pressure-locked steel bar grating, supported by steel angles. Limit openings in gratings to no more than 3/4 inch in least dimension.
7. Support each ladder at top and bottom and not more than 60 inches o.c. with welded or bolted steel brackets.
8. Galvanize exterior ladders, including brackets.

C. Aluminum Ladders:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Halliday Products; Orlando, FL.
b. O'Keeffe's Inc.; Brisbane, CA.
c. Precision Ladders, LLC.; Morristown, TN.
d. Thompson Fabricating, LLC.; Wheatland, PA.
e. Or Approved Equal.

2. Space siderails 16 inches apart unless otherwise indicated.
3. Siderails: Continuous extruded-aluminum channels or tubes, not less than 2-1/2 inches deep, 3/4 inch wide, and 1/8 inch thick.
4. Rungs: Extruded-aluminum tubes, not less than 3/4 inch deep and not less than 1/8 inch thick, with ribbed tread surfaces.
5. Fit rungs in centerline of siderails; fasten by welding or with stainless-steel fasteners or brackets and aluminum rivets.
6. Provide platforms as indicated fabricated from pressure-locked aluminum bar grating or extruded-aluminum plank grating, supported by extruded-aluminum framing. Limit openings in gratings to no more than 3/4 inch in least dimension.
7. Support each ladder at top and bottom and not more than 60 inches o.c. with welded or bolted aluminum brackets.
8. Provide minimum 72-inch-high, hinged security door with padlock hasp at foot of ladder to prevent unauthorized ladder use.

2.9 LADDER SAFETY CAGES

A. General:

1. Fabricate ladder safety cages to comply with ANSI A14.3. Assemble by welding or with stainless-steel fasteners.
2. Provide primary hoops at tops and bottoms of cages and spaced not more than 20 feet o.c. Provide secondary intermediate hoops spaced not more than 48 inches o.c. between primary hoops.
3. Fasten assembled safety cage to ladder rails and adjacent construction by welding or with stainless-steel fasteners unless otherwise indicated.

B. Steel Ladder Safety Cages:

1. Primary Hoops: 1/4-by-4-inch flat bar hoops.
2. Secondary Intermediate Hoops: 1/4-by-2-inch flat bar hoops.
3. Vertical Bars: 3/16-by-1-1/2-inch flat bars secured to each hoop.
4. Galvanize ladder safety cages, including brackets and fasteners.

C. Aluminum Ladder Safety Cages:

1. Primary Hoops: 1/4-by-4-inch flat bar hoops.
2. Secondary Intermediate Hoops: 1/4-by-2-inch flat bar hoops.
3. Vertical Bars: 1/4-by-2-inch flat bars secured to each hoop.

2.10 METAL SHIPS' LADDERS AND PIPE CROSSOVERS

A. Provide metal ships' ladders and pipe crossovers where indicated. Fabricate of open-type construction with channel or plate stringers and pipe and tube railings unless otherwise indicated. Provide brackets and fittings for installation.

1. Treads shall be not less than 5 inches exclusive of nosing or less than 8-1/2 inches including the nosing, and riser height shall be not more than 9-1/2 inches.
2. Fabricate ships' ladders and pipe crossovers, including railings from aluminum.

3. Fabricate treads and platforms from extruded-aluminum plank grating. Limit openings in gratings to no more than 3/4 inch in least dimension.
4. Fabricate treads and platforms from rolled-aluminum-alloy tread plate.
5. Comply with applicable railing requirements.

B. Galvanize exterior steel ships' ladders and pipe crossovers, including treads, railings, brackets, and fasteners.

2.11 METAL FLOOR PLATE

A. Fabricate from aluminum diamond floor plate of thickness indicated below:

1. Thickness: As required for loadings indicated.

B. Provide grating sections where indicated fabricated from extruded-aluminum plank grating. Limit openings in gratings to no more than 3/4 inch in least dimension.

C. Provide stainless-steel angle supports as indicated.

D. Include stainless-steel angle stiffeners, and fixed and removable sections as indicated.

E. Provide flush stainless-steel bar drop handles for lifting removable sections, one at each end of each section.

2.12 MISCELLANEOUS STEEL TRIM

A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.

B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.

1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.

C. Galvanize exterior miscellaneous steel trim.

2.13 METAL BOLLARDS

A. Fabricate metal bollards from Schedule 40 steel pipe.

1. Cap bollards with 1/4-inch-thick steel plate.
2. Where bollards are indicated to receive controls for door operators, provide cutouts for controls and holes for wire.
3. Where bollards are indicated to receive light fixtures, provide cutouts for fixtures and holes for wire.

B. Fabricate bollards with 3/8-inch-thick steel baseplates for bolting to concrete slab. Drill baseplates at all four corners for 3/4-inch anchor bolts.

1. Where bollards are to be anchored to sloping concrete slabs, angle baseplates for plumb alignment of bollards.

C. Fabricate sleeves for bollard anchorage from steel pipe or tubing with 1/4-inch-thick steel plate welded to bottom of sleeve. Make sleeves not less than 8 inches deep and 3/4 inch larger than OD of bollard.

D. Fabricate internal sleeves for removable bollards from Schedule 40 steel pipe or 1/4-inch wall-thickness steel tubing with an OD approximately 1/16 inch less than ID of bollards. Match drill sleeve and bollard for 3/4-inch steel machine bolt.

E. Prime bollards with zinc-rich primer.

2.14 ABRASIVE METAL NOSINGS TREADS AND THRESHOLDS

A. Provide abrasive metal nosing treads on all interior stair construction and thresholds for all interior/exterior doors.

B. Cast-Metal Units: Cast aluminum, with an integral-abrasive, as-cast finish consisting of aluminum oxide, silicon carbide, or a combination of both. Fabricate units in lengths necessary to accurately fit openings or conditions.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Victory Treads; Pelham, AL.
b. American Safety Tread Co., Inc.; Pelham, AL.
c. Balco, Inc.; Wichita, KS.
d. Safe-T-Metal Company, Inc.; Syracuse, NY.
e. Or Approved Equal.

2. Nosings: Cross-hatched units, 1-1/2 by 1-1/2 inches, for casting into concrete.
3. Treads: Cross-hatched units, full depth of tread with 3/4-by-3/4-inch nosing, for application over bent plate treads or existing stairs.
4. Thresholds: Fluted-saddle-type units, 5 inches wide by 1/2 inch high, with tapered edges.

C. Extruded Units: Aluminum, with abrasive filler consisting of aluminum oxide, silicon carbide, or a combination of both, in an epoxy-resin binder. Fabricate units in lengths necessary to accurately fit openings or conditions.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. ACL Industries, Inc.; Manchester, NH.
b. American Safety Tread Co., Inc.; Pelham, AL.

c. Balco, Inc.; Wichita, KS.
d. Or Approved Equal.

2. Provide ribbed units, with abrasive filler strips projecting 1/16 inch above aluminum extrusion.
3. Nosings: Square-back units, 3 inches wide, for casting into concrete steps.
4. Treads: Square-back units, full depth of tread with 1-3/8-inch lip, for application over existing stairs.

D. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with manufacturer.

E. Apply bituminous paint to concealed surfaces of cast-metal units.

F. Apply clear lacquer to concealed surfaces of extruded units.

2.15 METAL DOWNSPOUT BOOTS

A. Provide downspout boots made from aluminum in heights indicated with inlets of size and shape to suit downspouts. Provide units with flanges and holes for countersunk anchor bolts.

1. Outlet: Vertical, to discharge into pipe OR at 35 degrees from horizontal, to discharge onto splash block or pavement.

2.16 LOOSE BEARING AND LEVELING PLATES

A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.

B. Galvanize plates.

C. Prime plates with zinc-rich primer.

2.17 LOOSE STEEL LINTELS

A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.

B. Galvanize and prime loose steel lintels located in exterior walls.

C. Prime loose steel lintels located in exterior walls with zinc-rich primer.

2.18 STEEL WELD PLATES AND ANGLES

A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

2.19 FINISHES, GENERAL

A. Finish metal fabrications after assembly.

B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.20 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153 for steel and iron hardware and with ASTM A 123 for other steel and iron products.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

B. Preparation for Shop Priming Galvanized Items: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.

C. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.

D. Preparation for Shop Priming: Prepare surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

2.21 ALUMINUM FINISHES

A. As-Fabricated Finish: AA-M12.

B. Clear Anodic Finish: AAMA 611, Class I, AA-M12C22A41.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.

Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

F. Corrosion Protection: Coat concealed surfaces of aluminum that come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:

1. Cast Aluminum: Heavy coat of bituminous paint.
2. Extruded Aluminum: Two coats of clear lacquer.

3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

B. Anchor supports for overhead doors securely to, and rigidly brace from, building structure.

C. Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.

1. Where grout space under bearing plates is indicated for girders supported on concrete or masonry, install as specified in "Installing Bearing and Leveling Plates" Article.

D. Install pipe columns on concrete footings with grouted baseplates. Position and grout column baseplates as specified in "Installing Bearing and Leveling Plates" Article.

1. Grout baseplates of columns supporting steel girders after girders are installed and leveled.

3.3 INSTALLING METAL BOLLARDS

A. Fill metal-capped bollards solidly with concrete and allow concrete to cure seven days before installing.

1. Do not fill removable bollards with concrete.

B. Anchor bollards to existing construction with anchor bolts. Provide four 3/4-inch bolts at each bollard unless otherwise indicated.

1. Embed anchor bolts at least 4 inches in concrete.

C. Anchor bollards in concrete in formed or core-drilled holes not less than 8 inches deep and 3/4 inch larger than OD of bollard. Fill annular space around bollard solidly with nonshrink grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately 1/8 inch toward bollard.

D. Anchor internal sleeves for removable bollards in formed or core-drilled holes not less than 8 inches deep and 3/4 inch larger than OD of sleeve. Fill annular space around internal sleeves solidly with nonshrink grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately 1/8 inch toward internal sleeve.

E. Place removable bollards over internal sleeves and secure with 3/4-inch machine bolts and nuts. After tightening nuts, drill holes in bolts for inserting padlocks. Owner furnishes padlocks.

F. Fill bollards solidly with concrete, mounding top surface to shed water.

1. Do not fill removable bollards with concrete.

3.4 INSTALLING NOSINGS, TREADS, AND THRESHOLDS

A. Center nosings on tread widths unless otherwise indicated.

B. For nosings embedded in concrete steps or curbs, align nosings flush with riser faces and level with tread surfaces.

C. Seal thresholds exposed to exterior with elastomeric sealant complying with Section 07 92 00 - Joint Sealants to provide a watertight installation.

3.5 INSTALLING BEARING AND LEVELING PLATES

A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.

B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with nonshrink grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.6 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified.

C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 05 50 00

SECTION 05 53 16 - PLANK GRATINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes extruded-aluminum plank gratings and metal frames and supports for gratings.

1.2 COORDINATION

A. Coordinate installation of anchorages for gratings, grating frames, and supports. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Extruded-aluminum plank gratings.

B. Shop Drawings: Include plans, sections, details, and attachments to other work.

C. Delegated-Design Submittal: For gratings, including manufacturers' published load tables and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Mill Certificates: Signed by manufacturers of stainless-steel sheet certifying that products furnished comply with requirements.

B. Welding certificates.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.2, "Structural Welding Code - Aluminum."

1.6 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with gratings by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Ohio Gratings, Inc.
2. Grating Pacific
3. All American Grating.
4. Harsco Industrial IKG, a division of Harsco Corporation.
5. Or Approved Equivalent

2.2 PERFORMANCE REQUIREMENTS

A. Structural Performance: Gratings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Floors: Uniform load of 150 lbf/sq. ft. or concentrated load of 2000 lbf, whichever produces the greater stress.
2. Walkways and Elevated Platforms Used as Exits: Uniform load of 125 lbf/sq. ft.
3. Limit deflection to L/360 or 1/4 inch, whichever is less.

2.3 EXTRUDED-ALUMINUM PLANK GRATINGS

A. Provide extruded-aluminum plank gratings in type, size, and finish indicated as indicated in the project Drawings to match the existing gratings and as needed to support structural loads. If not indicated, provide aluminum plank gratings as recommended by manufacturer for indicated applications and as needed to support indicated loads.

1. Type: Extruded-aluminum planks approximately 6 inches wide with multiple flanges approximately 1.2 inches o.c., acting as bearing bars connected by a web that serves as a walking surface. Top surface has raised ribs to increase slip resistance.
2. Depth: As required to comply with structural performance requirements.
3. Perforations: Rectangular, 19/32 by 3 inches with adjacent rows staggered
4. Finish: Mill finish, as fabricated.

2.4 ALUMINUM

A. Aluminum, General: Provide alloy and temper recommended by aluminum producer and finisher for type of use indicated, and with not less than the strength and durability properties of alloy and temper designated below for each aluminum form required.

B. Extruded Bars and Shapes: ASTM B221, alloys as follows:

1. 6061-T6 or 6063-T6, for bearing bars of gratings and shapes.
2. 6061-T1, for grating crossbars.

C. Aluminum Sheet: ASTM B209, Alloy 5052-H32.

2.5 FASTENERS

A. General: Unless otherwise indicated, provide Type 316 stainless-steel fasteners for exterior use. Select fasteners for type, grade, and class required.

1. Provide stainless-steel fasteners for fastening aluminum.
2. Provide stainless steel fasteners for fastening stainless steel.

B. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, nuts, and, where indicated, flat washers; ASTM F593 for bolts and ASTM F594 for nuts, Alloy Group 2.

C. Post-Installed Anchors: Torque-controlled expansion anchors capable of sustaining, without failure, a load equal to 6 times the load imposed when installed in unit masonry and 4 times the load imposed when installed in concrete, as determined by testing according to ASTM E488/E488M, conducted by a qualified independent testing agency.

1. Material for All Locations and Where Stainless Steel Is Indicated: Alloy Group 2 stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594.

2.6 MISCELLANEOUS MATERIALS

A. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187.

2.7 FABRICATION

A. Shop Assembly: Fabricate grating sections in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch material cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Fit exposed connections accurately together to form hairline joints.

D. Welding: Comply with AWS recommendations and the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.

E. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space the anchoring devices to secure gratings, frames, and supports rigidly in place and to support indicated loads.

1. Fabricate toeplates for attaching in the field.
2. Toeplate Height: 4 inches unless otherwise indicated.

F. Removable Grating Sections: Fabricate with banding bars attached by welding to entire perimeter of each section. Include anchors and fasteners of type indicated or, if not indicated, as recommended by manufacturer for attaching to supports.

G. Fabricate cutouts in grating sections for penetrations of sizes and at locations indicated. Cut openings neatly and accurately to size. Edge-band openings with metal sheet or bars having a thickness not less than grating material.

1. Arrange cutouts to permit grating removal without disturbing items penetrating gratings.

H. Where gratings are pierced by pipes, ducts, and structural members, cut openings neatly and accurately to size and weld a strap collar not less than 1/8 inch thick to the cut ends. Divide panels into sections only to extent required for installation where grating platforms and runways are to be placed around previously installed pipe, ducts, and structural members.

2.8 GRATING FRAMES AND SUPPORTS

A. Frames and Supports: Fabricate from metal shapes, plates, and bars of welded construction to sizes, shapes, and profiles indicated and as necessary to receive gratings. Miter and weld connections for perimeter angle frames. Cut, drill, and tap units to receive hardware and similar items.

1. Unless otherwise indicated, fabricate from same basic metal as gratings.
2. Equip units indicated to be cast into concrete or built into masonry with integrally welded anchors. Unless otherwise indicated, space anchors 24 inches o.c. and provide minimum anchor units in the form of steel straps 1-1/4 inches wide by 1/4 inch thick by 8 inches long.

2.9 ALUMINUM FINISHES

A. Class I, Clear Anodic Finish: AA-M12C22A41 complying with AAMA 611.

B. The portion of aluminum frames in contact with concrete shall have a bitumastic coating for protection.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing gratings to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing gratings. Set units accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete or masonry.

D. Fit exposed connections accurately together to form hairline joints.

1. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade the surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

E. Attach toeplates to gratings by welding at locations indicated.

F. Field Welding: Comply with AWS recommendations and the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.

G. Corrosion Protection: Coat concealed surfaces of aluminum that come into contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

3.2 INSTALLING METAL PLANK GRATINGS

A. General: Comply with manufacturer's written instructions for installing gratings. Use manufacturer's standard anchor clips and hold-down devices for bolted connections.

B. Attach removable units to supporting members by bolting at every point of contact.

C. Attach nonremovable units to supporting members by welding unless otherwise indicated. Comply with manufacturer's written instructions for size and spacing of welds.

D. Attach aluminum units to steel supporting members by bolting at side channels at every point of contact and by bolting intermediate planks at each end on alternate sides. Bolt adjacent planks together at midspan.

3.3 ADJUSTING AND CLEANING

A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas, and repair galvanizing to comply with ASTM A780.

END OF SECTION 05 53 16

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 07 92 00 – JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes: joint sealer systems.

1.2 RELATED DOCUMENTS

A. Related work specified elsewhere includes:

1. Section 03 30 00 – Cast-in-Place Concrete.
2. Section 09 96 00 – High-Performance Coatings.

1.3 SYSTEM PERFORMANCES

A. Provide joint sealers that have been produced and installed to establish and maintain watertight and airtight continuous seals.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's product specifications, handling, installation, curing instructions, color charts and performance tested data sheets for each product required.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Engage an Installer who has successfully completed within the last three years at least three (3) joint sealer applications similar in type and size to that of this project and who will assign mechanics from these earlier applications to this project, of which one will serve as lead mechanic.

B. Single Source Responsibility for Joint Sealer Materials: Obtain joint sealer materials from a single manufacturer for each different product required.

1.6 DELIVER, STORAGE AND HANDLING

A. Deliver materials to project site in original unopened containers or bundles with labels informing about manufacturer, product name and designation, color, expiration period for use, pot life, curing time and mixing instructions for multi-component materials.

B. Store and handle materials to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.7 PROJECT CONDITIONS

A. Environmental Conditions: Do not proceed with installation of joint sealers under the following conditions:

1. When ambient and substrate temperature conditions are outside the limits permitted by joint sealer manufacturer or below 40ºF.
2. When joint substrates are wet due to rain, frost, condensation or other causes.

B. Joint Width Conditions: Do not proceed with installation of joint sealers when joint widths are less than allowed by joint sealer manufacturer for application indicated.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Compatibility: Provide joint sealers, joint fillers and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by testing and field experience.

B. Colors: Provide color of exposed joint sealers indicated or, if not otherwise indicated, as selected by from manufacturer's standard colors.

2.2 ELASTOMERIC JOINT SEALANTS

A. Elastomeric Sealant Standard: Provide manufacturer's standard chemically curing, elastomeric sealant of base polymer indicated which complies with ASTM C 920 requirements, including those for Type, Grade, Class and Uses.

B. Multi-Part Nonsag Urethane Sealant: Type M, Grade NS, Class 25, Uses NR, M, A and, as applicable to joint substrates indicated, O.

1. Products: Subject to compliance with requirements, provide one of the following:

a. "Dynatrol 11'" Pecora Corp.
b. "Sonolastic NP-2"; Sonneborn.
c. "Dymeric 511"; Tremco Inc.
d. "Vulkem 922"; Mameco International, Inc.
e. Or Approved Equal.

2. Locations for Use: Exterior joints and penetrations in vertical surfaces of stucco, concrete, and between metal and concrete, mortar of stone; overhead or ceiling joints; perimeters of metal frames in exterior walls; vertical expansion and control joints in masonry and concrete; and at all miscellaneous locations requiring a joint sealant.
3. Equivalent 1-part sealants will be acceptable, by one of the above named manufacturers.

C. Two-Part Pourable Urethane Sealant: Type M, Grade P, Class 25; Uses T, M, A and, as applicable to joint substrates indicated, O.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. "Chem-Calk 550"; Bostik Construction Product Div.
    b. "Vulkem 245"; Mameco International, Inc.
    c. "Pourthane"; W. R. Meadows, Inc.
    d. "NR-200 Urexpan"; Pecora Corp.
    e. "Sonolastic Paving Joint Sealant"; Sonneborn Building Products Div.,
    f. "Rexnord Chem. Prod. Inc.
    g. "THC-900/901"; Tremco Corp.
    h. Or Approved Equal.

2. Locations for Use: Exterior and interior expansion, control and construction joints in horizontal surfaces; and joints subject to pedestrian and light vehicular traffic.
3. Equivalent 1-part sealants will be acceptable, by one of the above named manufacturers.

D. One-Part Mildew-Resistant Silicone Sealant: Type S, Grade NS; Class 25, Uses NT, G, A and, as applicable to nonporous joint substrates indicated, O; formulated with fungicide for sealing interior joints with nonporous substrates around ceramic tile, showers, sinks and plumbing fixtures.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. "Dow-Corning 786"; Dow Corning Corp.
    b. "SCS 1702"; General Electric.
    c. "863 #345 White"; Pecora Corp.
    d. "Proglaze White"; Tremco Corp.
    e. Or Approved Equal.

2. Locations for Use: Interior joints in vertical surfaces and terminal edges of tile; and joints at damp areas, such as around sinks and plumbing fixtures and pipe penetrations; and exposed terminal edges of vinyl flooring, such as around door frames and terminations at concrete.

2.3 LATEX JOINT SEALERS

A. Acrylic-Emulsion Sealant: Manufacturer's standard, one part nonsag, acrylic, mildew resistant, acrylic emulsion sealant complying with ASTM C 834, formulated to be paintable and recommended for exposed applications on interior and on protected exterior exposures involving joint movement of not more than + 7.5%.

1. Products: Subject to compliance with requirements, provide with one of the following:

    a. "Chem-Calk 600"; Bostik Construction Products Div.
    b. "AC-20"; Pecora Corp.
    c. "Sonolac"; Sonneborn Building Products Div; Rexnord Chemical Prod., Inc.
    d. "Tremco Acrylic Latex Caulk"; Tremco Inc.
    e. Or Approved Equal.

2. Locations for Use: Interior joints in field-painted vertical and overhead surfaces at perimeter of metal door frames, gypsum drywall, plaster and concrete or concrete masonry; and all other interior locations not indicated otherwise.

2.4 JOINT SEALANT BACKING

A. General: Provide sealant backings of material and type which are non-staining; are compatible with joint substrates, sealants, primers and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Plastic Foam Joint-Fillers:

1. Preformed, compressible, resilient, non-waxing, non-extruding strips of plastic foam of material indicated below, and of size, shape and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
2. Backer Rod: Premium grade, closed cell polyethylene foam rod; Sealtight Backer Rod, as manufactured by W.R. Meadows, Inc., or approved equal.
3. Joint Filler: "Ceramar" flexible foam expansion joint filler, as manufactured by W.R. Meadows, Inc., or approved equal.

C. Bond Breaker Tape: Polyethylene tape or other plastic tape as recommended by sealant manufacturer for preventing bond between sealant and joint filler or other materials at back (3rd) surface of joint. Provide self-adhesive tape where applicable.

2.5 MISCELLANEOUS MATERIALS

A. Primer: Provide type recommended by joint sealer manufacturer where required for adhesion of sealant to joint substrates indicated.

B. Cleaners for Nonporous Surfaces: Provide non-staining, chemical cleaner of type acceptable to manufacturer of sealant and sealant backing materials which are not harmful to substrates and adjacent nonporous materials.

C. Masking Tape: Provide non-staining, non-absorbent type compatible with joint sealants and to surface adjacent to joints.

PART 3 - EXECUTION

3.1 INSPECTION

A. Require Installer to inspect joints indicated to receive joint sealers for compliance with requirements for joint configuration, installation tolerances and other conditions affecting joint sealer performance. Obtain Installer's written report listing any conditions detrimental to performance of joint sealer work. Do not allow joint sealer work to proceed until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealers to comply with recommendations of joint sealer manufacturers and the following requirements:

1. Remove all foreign material from joint substrates which could interfere with adhesion of joint sealer, including dust; paints, except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer; oil; grease; waterproofing; water repellents; water; surface dirt and frost.
2. Clean concrete, masonry, unglazed surfaces of ceramic tile and similar porous joint substrate surfaces, by brushing, grinding, blast cleaning, mechanical abrading, acid washing or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealers. Remove loose particles remaining from above cleaning operations by vacuuming or blowing out joints with oil-free compressed air.
3. Remove laitance and form release agents from concrete.
4. Clean metal, glass, porcelain enamel, glazed surfaces of ceramic tile and other non-porous surfaces by chemical cleaners or other means which are not harmful to substrates or leave residues capable of interfering with adhesion of joint sealers.

B. Joint Priming: Prime joint substrates where indicated or where recommended by joint sealer manufacturer based on preconstruction joint sealer-substrate tests or prior experience. Apply primer to comply with joint sealer manufacturer's recommendations. Confine primers to areas of joint sealer bond, do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces which otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALERS

A. General: Comply with joint sealer manufacturer's printed installation instructions applicable to products and applications indicated, except where more stringent requirements apply.

B. Elastomeric Sealant Installation Standard: Comply with recommendations of ASTM C 1193 for use of joint sealants as applicable to materials, applications and conditions indicated.

C. Latex Sealant Installation Standard: Comply with requirements of ASTM C 790 for use of latex sealants.

D. Installation of Sealant Backings:

1. Install sealant backings to comply with the following requirements:
2. Install joint-fillers of type indicated or recommended by sealant manufacturer to provide support of sealants during application and at position required to produce the cross-sectional shapes and depths of installed sealants relative to joint widths which allow optimum sealant movement capability.

    a. Do not leave gaps between ends of joint-fillers.

b. Do not stretch, twist, puncture or tear joint-fillers.
c. Remove absorbent joint-fillers which have become wet prior to sealant application and replace with dry material.

3. Install bond breaker tape between sealants and joint-fillers, compression seals or back of joints where required to prevent third-side adhesion of sealant to back of joint.

E. Installation of Sealants: Install sealants by proven techniques that result in sealants directly contacting and fully wetting joint substrates, completely filling recesses provided for each joint configuration and providing uniform, cross-sectional shapes and depths relative to joint widths which allow optimum sealant movement capability.

F. Tooling of Nonsag Sealants:

1. Immediately after sealant application and prior to time skinning or curing begins, tool sealants to form smooth, uniform beads of configuration indicated, to eliminate air pockets and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents which discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.
2. Concave joint configuration per Figure 5A in ASTM C 1193, unless otherwise indicated.

3.4 PROTECTION AND CLEANING

A. Protect joint sealers during and after curing period from contact with contaminating substances or from damage resulting from construction operations or other causes so that they 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 sealers immediately and reseal joints with new materials to produce joint sealer installations with repaired areas indistinguishable from original work.

B. Clean off excess sealants or sealant smears adjacent to joints as work progresses by methods and with cleaning materials approved by manufacturers of joint sealers and of products in which joints occur.

1. Sound sealant shall not be visible on exposed surfaces.

END OF SECTION 07 92 00

SECTION 09 96 00 - HIGH-PERFORMANCE COATINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: High-performance coatings and special preparation of surfaces.

1. Use high performance coating systems specified in this section to finish water tank components, unless otherwise indicated. Without restricting volume or generality, work to be performed under this section may include, but is not limited to:

    a. Exterior steel
    b. Interior steel
    c. Exterior concrete
    d. Interior concrete
    e. Piping, hangers, and supports
    f. Exposed bare pipes (including color coding)

2. Painting or finishing is not needed for following:

    a. Surfaces or materials specifically scheduled or shown on Drawings to remain unfinished
    b. Items provided with factory finish.
    c. Equipment nameplates, fire rating labels, and operating parts of equipment

3. Materials and products having factory-applied primer shall not be considered factory finished.

1.2 REFERENCE STANDARDS

A. American Society for Testing and Materials:

1. ASTM D16 - Terminology Relating to Paint, Varnish, Lacquer, and Related Products

B. SSPC: The Society for Protective Coatings:

1. SSPC - Painting Manual, Volume 2: Systems and Specifications.
2. SSPC-Paint 16 - Coal Tar Epoxy-Polyamide Black (or Dark Red).
3. SSPC-SP 2 - Hand Tool Cleaning.
4. SSPC-SP 3 - Power Tool Cleaning.
5. SSPC-SP 5 - White Metal Blast Cleaning.
6. SSPC-SP 6 - Commercial Blast Cleaning.
7. SSPC-SP 7 - Brush-Off Blast Cleaning.
8. SSPC-SP 10 - Near-White Metal Blast Cleaning.
9. SSPC-SP 11 - Power Tool Cleaning to Bare Metal.

C. National Association of Pipe Fabricators

1. NAPF 500-03-01 Solvent Cleaning
2. NAPF 500-03-02 Hand Tool Cleaning
3. NAPF 500-03-03 Power Tool Cleaning
4. NAPF 500-03-04 Abrasive Blast Cleaning of Ductile Iron Pipe
5. NAPF 500-03-05 Abrasive Blast Cleaning of Cast Ductile Iron Fittings

1.3 PREINSTALLATION MEETINGS

A. Section 01 31 00 – Project Management and Coordination.

B. Convene minimum two weeks prior to commencing Work of this Section.

C. Schedule a conference and inspection to be held on-site before field application of coating systems begins.

D. Conference shall be attended by Contractor, Owner's Representative, Engineer, coating applicators, and a representative of coating material manufacturer.

E. Topics to be discussed at meeting shall include:

1. A review of Contract Documents and accepted shop drawings shall be made and deviations or differences shall be resolved.
2. Review items such as environmental conditions, surface conditions, surface preparation, application procedures, and protection following application.
3. Establish which areas on-site will be available for use as storage areas and working area

F. Pre-construction conference and inspection shall serve to clarify Contract Documents, application requirements and what work should be completed before coating application can begin.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data:

1. Submit manufacturer information indicating coating materials, manufacturer’s name, product name, product number, performance ratings, curing times, mixing, thinning and application requirements.

    a. Provide material analysis, including vehicle type and percentage by weight and by volume of vehicle, resin and pigment.
    b. Submit manufacturer's Material Safety Data Sheets (MSDS) and other safety requirements.

C. Samples: Submit one color chart/color samples, illustrating colors for selection.

D. Schedule: Contractor shall submit a schedule of items that will receive high-performance coatings per Specification 09 96 00.

E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

F. Manufacturer Instructions: Submit special procedures, perimeter conditions requiring special attention.

G. Quality Assurance Submittals:

1. Certificates:

a. Coatings manufacturer shall certify that coating materials utilized are "non-lead" (less than 0.06% lead by weight in dried film) as defined in Part 1303 of Consumer Product Safety Act.
b. Provide certification that specialized equipment as may be required by manufacturer for proper application of coating materials shall be utilized for work of this Section.
c. Provide manufacturer's certification that products to be used comply with specified requirements and are suitable for intended application.

2. Manufacturer's Instructions:

a. Submit manufacturer's installation procedures which shall be basis for accepting or rejecting actual installation procedures.

H. Qualifications Statements:

1. Submit qualifications for manufacturer and applicator.
2. Submit manufacturer's approval of applicator.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Operation and Maintenance Data: Submit maintenance and cleaning requirements for coatings, repair, and patching techniques.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance materials.

B. Extra Stock Materials:

1. Furnish 1 gal of each color of each type of coating specified, for Owner's maintenance use.
2. Label each container with manufacturer's name, product number, color number, and room names and numbers where used.

1.7 QUALITY ASSURANCE

A. Conform to applicable codes and ordinances for flame, fuel, smoke, and volatile organic compound (VOC) ratings requirements for finishes at time of application.

1.8 QUALIFICATIONS

A. Provide products from a company specializing in manufacture of high performance coatings with a minimum of 10 years experience.

B. Applicator shall be trained in application techniques and procedures of coating materials and shall demonstrate a minimum of 2 years successful experience in such application.

1. Maintain, throughout duration of application, a crew of painters who are fully qualified to satisfy specified qualifications.

C. Single Source Responsibility:

1. Materials shall be products of a single manufacturer or items standard with manufacturer of specified coating materials.
2. Provide secondary materials which are produced or are specifically recommended by coating system manufacturer to ensure compatibility of system.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Container Labeling: Include manufacturer's name, type of coating, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.

C. Inspection:

1. Accept materials on Site in manufacturer's sealed and labeled containers.
2. Inspect for damage and to verify acceptability.

D. Store materials in ventilated area and otherwise according to manufacturer instructions.

E. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.10 AMBIENT CONDITIONS

A. Section 01 50 00 - Temporary Facilities and Controls: Requirements for ambient condition control facilities for product storage and installation.

B. Minimum Conditions: Do not install materials when temperature is below 35°F or above 110°F.

C. Refer to specific product information sheets for minimum surface temperature requirements. Surface temperatures shall be at least 5°F (15°C) above dew point and in a rising mode.

D. Subsequent Conditions: Maintain above temperature range, 24 hours before, during, and 72 hours after installation of coating.

E. Relative humidity shall be no higher than 85%.

F. For exterior spray application, wind velocity shall be less than 15 mph (25 kph).

G. Atmosphere shall be relatively free of airborne dust.

H. Restrict traffic from area where coating is being applied or is curing.

1.11 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. Include coverage for bond to substrate, and degradation of chemical resistance.

PART 2 - PRODUCTS

2.1 HIGH-PERFORMANCE COATINGS

A. Manufacturers:

1. Tnemec Company, Inc.
2. Sherwin Williams Company
3. Carboline
4. Or Approved Equal.

2.2 COMPONENTS

A. Coatings:

1. Description:

a. Complete multicoat systems formulated and recommended by manufacturer for intended applications and in indicated thicknesses.
b. Specified number of coats does not include primer or filler coat.

2. Lead content: None.
3. Chromium Content as Zinc Chromate or Strontium Chromate: None.
4. Maximum VOC Content: As required by applicable regulations.
5. Colors: As selected from manufacturer's standard colors.

B. Epoxy Coating:

1. Modified Polyamine Epoxy

   a. Usage: A thick film, 100% solids, abrasion-resistant lining designed for wastewater immersion and fume environments. Provides low permeation to H2S gas, protects against MIC and provides chemical resistance to severe wastewater environments.
   b. Exposure: Severe.
   c. Number of Coats: See schedule.
   d. Finish: Gloss.
   e. Minimum Solids Content: 100% (mixed).
   f. Minimum Dry Film Thickness Per Coat: See schedule.
   g. Perma-Glaze, Series 435, as manufactured by Tnemec, or DuraPlate 5900, as manufactured by Sherwin Williams.
   h. Primer: See schedule.

2. Modified Polyamine Epoxy Mortar

   a. Usage: A 100% solids, hybrid epoxy mortar designed for severe wastewater immersion and fume environments. Specifically formulated to withstand high levels of hydrogen sulfide gas (H2S), sulfuric acid (H2SO4), as well as other gases common to sewer exposures. Aggregate reinforcement provides additional resistance to abrasions and impacts.
   b. Exposure: Severe.
   c. Number of Coats: See schedule.
   d. Finish: Gloss.
   e. Minimum Solids Content: 100% (mixed).
   f. Minimum Dry Film Thickness Per Coat: See schedule.
   g. Perma-Shield H2S, Series 434, as manufactured by Tnemec, or DuraPlate 5900 Mortar, as manufactured by Sherwin Williams.
   h. Primer: See schedule.

3. Glass Flake Modified Polyamine Epoxy

   a. Usage: Abrasion resistant, high solids, epoxy coating which offers high-build edge protection and excellent corrosion resistance. Contains glass flake and aluminum oxide for improved film integrity.
   b. Exposure: Severe.
   c. Number of Coats: See schedule.
   d. Minimum Solids Content: 82.0 ± 2.0%
   e. Minimum Dry Film Thickness Per Coat: 8 -18 mils DFT
   f. Epoxoline, Series 142, as manufactured by Tnemec, or Macropoxy 5500LT, as manufactured by Sherwin Williams.
   g. Primer: See schedule.

4. Modified Polyamine Epoxy

   a. Usage: NSF Approved, abrasion resistant, high solids, epoxy coating which offers high-build edge protection and excellent corrosion resistance.
   b. Exposure: Severe.

c. Number of Coats: See schedule.
d. Minimum Solids Content: 82.0 ± 2.0%
e. Minimum Dry Film Thickness Per Coat: 4 -18 mils DFT
f. Epoxoline, Series 141, as manufactured by Tnemec, or Macropoxy 5500LT, as manufactured by Sherwin Williams.
g. Primer: See schedule.

5. Surface Tolerant Modified Polyamidoamine Epoxy

a. Usage: High-build coating with superior wetting for marginally prepared rusty steel and tightly adhering old coatings. Excellent abrasion-, chemical- and corrosion-resistance. Perfect foundation for aliphatic-polyurethanes. NOT FOR IMMERSION SERVICE.
b. Exposure: Moderate.
c. Number of Coats: See schedule.
d. Finish: Semi-gloss.
e. Minimum Solids Content: 84.0 ± 2.0% (mixed).
f. Minimum Dry Film Thickness Per Coat: See schedule.
g. Chembuild, Series 135, as manufactured by Tnemec, or Macropoxy 5500 LT, as manufactured by Sherwin Williams.
h. Primer: See schedule.

6. NSF Approved Pure Polyamide Epoxy

a. Usage: Potable water coating which offers high-build edge protection and allows for application at a wide range of temperatures (down to 35°F or 2°C). For use on the interior and exterior of steel or concrete tanks, reservoirs, pipes, valves, pumps and equipment in potable water service.
b. NSF Certification: Yes
c. Exposure: Moderate.
d. Number of Coats: See schedule.
e. Minimum Solids Content: 56.0 ± 2.0%
f. Minimum Dry Film Thickness Per Coat: See schedule.
g. Pota-Pox, Series 20 or 20HS, as manufactured by Tnemec, or Macropoxy 646 PW, as manufactured by Sherwin Williams.
h. Primer: See schedule.

7. Polyamidoamine Epoxy

a. Usage: Potable water and wastewater primer which offers high-build edge protection and allows for application at a wide range of temperatures (down to 35°F or 2°C). For use on the interior and exterior of steel or concrete tanks, reservoirs, pipes, valves, pumps and equipment in potable water service.
b. Exposure: Moderate.
c. Number of Coats: See schedule.
d. Color: 1211 Red – Ductile Iron Pipe
e. Minimum Solids Content: 67.0 ± 2.0% (mixed).
f. Minimum Dry Film Thickness Per Coat: See schedule.
g. Pota-Pox Plus, Series N140, as manufactured by Tnemec, or Macropoxy 5500LT, as manufactured by Sherwin Williams.
h. Primer: See schedule.

8. High-Build Epoxy Coating – Pure Polyamide Epoxy

    a. Usage: Application characteristics in adverse and varied conditions.
    b. Exposure: Moderate.
    c. Number of Coats: See schedule.
    d. Finish: Satin.
    e. Minimum Solids Content: 56.0% +/- 2.0% (mixed).
    f. Minimum Dry Film Thickness Per Coat: See schedule.
    g. Hi-Build Epoxoline, Series 66 or 66HS, as manufactured by Tnemec, or Macropoxy 646 Fast Cure, as manufactured by Sherwin Williams.
    h. Primer: See schedule.

9. Waterborne Acrylic Epoxy

    a. Usage: High performance coating suitable for concrete, steel and other commonly used building materials. Features include high-build, low odor, non-yellowing white and fade resistant colors; easy cleanup and stain-, abrasion-, chemical- and moisture-resistance. Good exterior performance.
    b. Exposure: Moderate
    c. Number of Coats: See schedule.
    d. Color: Refer to Tnemec Color Guide.
    e. Finish: Satin.
    f. Minimum Solids Content: 44.0 ± 2.0% (mixed)
    g. Minimum Dry Film Thickness Per Coat: See schedule.
    h. H.B. Tneme-Tufcoat, Series 113, as manufactured by Tnemec, or Pro Industrial Water Based Epoxy.
    i. Primer: See schedule.

10. Modified Polyamine Epoxy

    a. Usage: High-solids moisture tolerant epoxy used for priming concrete, wood and drywall. Also as a stand-alone one-coat clear floor sealer.
    b. Exposure:
    c. Number of Coats: See schedule.
    d. Color: Clear. Can be field-tinted (Series 820 Field Tint) in 16 StrataShield colors and certain custom colors. Sherwin Williams products is available in clear standard and customer colors
    e. Minimum Solids Content: 100% (mixed).
    f. Minimum Dry Film Thickness Per Coat: See schedule.
    g. Epoxoprime, Series 201, as manufactured by Tnemec, or General Polymers 3746, as manufactured by Sherwin Williams.
    h. Primer: See schedule.

11. Modified Polyamine Epoxy

    a. Usage: A multi-purpose epoxy coating that can be used as a primer, broadcast, slurry/broadcast, mortar, grout coat, and topcoat. Excellent application properties with good flow and self-leveling characteristics. Protects concrete surfaces from impact, abrasion and mild chemicals.

b. Exposure: Moderate.
c. Number of Coats: See schedule.
d. Color: Clear or pigmented. Can be factory or field-tinted (Series 820 Field Tint) in 16 StrataShield colors and certain custom colors. Reference Sherwin Williams data sheets for color details
e. Minimum Solids Content: 100% (mixed).
f. Minimum Dry Film Thickness Per Coat: See schedule.
g. Power-Tread, Series 237, as manufactured by Tnemec, or General Polymers 4080 (FasTop 12S), as manufactured by Sherwin Williams.
h. Primer: See schedule.

12. Modified Novolac Epoxy

a. Usage: A multi-purpose resin for fiberglass reinforced mat secondary containment systems. Protects against chemicals, thermal cycling, impact and abrasion.
b. Exposure: Severe/moderate
c. Number of Coats: See schedule.
d. Color: 00GR Gray or clear from Sherwin Williams.
e. Minimum Solids Content: 100% (mixed)
f. Minimum Dry Film Thickness Per Coat: See schedule.
g. Chembloc, Series 239SC, as manufactured by Tnemec, or Cor-Cote HCR, as manufactured by Sherwin Williams.
h. Primer: See schedule.

C. Polyurethane Coating:

1. Modified Aromatic Polyurethane Primer

a. Usage: A single component, surface tolerant, NSF approved, moisture-cured resin, containing micaceous iron oxide and zinc to function as a primer which is field and shop friendly. Exposure: Moderate.
b. Number of Coats: See schedule.
c. Color: 1216 Greenish-Gray.
d. Minimum Solids Content: 61.0 ± 2.0% (mixed).
e. Minimum Dry Film Thickness Per Coat: See schedule.
f. Omnithane, Series 1, as manufactured by Tnemec, or Corothane 1 GalvaPac 1K or 2K Zinc Primer, as manufacturd by Sherwin Williams.
g. Primer: See schedule.

2. Aromatic Urethane, Zinc-Rich Primer

a. Usage: A two-component, moisture-cured, zinc-rich urethane primer for the interior and exterior steel surfaces. Exposure: Moderate.
b. Color: Greenish-gray.
c. Minimum Solids Content: 63.0 ± 2.0% (mixed).
d. Metallic Zinc Content: 83% minimum in dried film. ASTM D 522 Type III Zinc dust.
e. Standard of Quality: Hydro-Zinc, Series 91-H_20, as manufactured by Tnemec, or Corothane 1 GalvaPac 1K or 2K Zinc Primer, as manufactured by Sherwin Williams.

f. Primer: See schedule.

3. Aliphatic Acrylic Polyurethane

a. Usage: A coating highly resistant to abrasion, wet conditions, corrosive fumes and exterior weathering. High build quality combines with project specific primers for two-coat, labor saving systems. Fast curing options are available; see Curing Time below. NOT FOR IMMERSION SERVICE.
b. Exposure: Moderate.
c. Number of Coats: See schedule.
d. Finish: Gloss.
e. Minimum Solids Content: 66 ± 2.0% (mixed).
f. Minimum Dry Film Thickness Per Coat: See schedule.
g. Endura-Shield, Series 1095, as manufactured by Tnemec, or Acolon 218 HS, as manufactured by Sherwin Williams.
h. Primer: See schedule.

4. Aliphatic Moisture Cured Urethane

a. Usage: Extremely hard, chemical-resistant urethane floor coating with superb wear characteristics. Excellent resistance to abrasion, wet conditions, corrosive fumes and chemical contact. Excellent gloss and color retention. Low odor characteristic allows for use near occupied space. Note: For horizontal surfaces only.
b. Exposure: Moderate.
c. Number of Coats: See schedule.
d. Finish: Semi-gloss.
e. Minimum Solids Content: 92 ± 2.0% (clear mixed).
f. Minimum Dry Film Thickness Per Coat: See schedule.
g. Everthane, Series 248, as manufactured by Tnemec, or Amorseal Rexthane 1, as manufactured by Sherwin Williams.
h. Primer: See schedule.

5. Polyurethane Modified Concrete

a. Usage: High performance designed to reduce moisture vapor emissions prior to the application of non-breathing, polymer floor topping finishes. Must be able to withstand up to 20lbs moisture vapor transmission and 99% RH.
b. Exposure: Moderate/Severe
c. Number of Coats: See schedule.
d. Finish: Matt.
e. Minimum Solids Content: 100%%.
f. Minimum Dry Film Thickness Per Coat: See schedule.
g. Everthane, Series 241 MVT, as manufactured by Tnemec, or General Polymers FasTop 12S, as manufactured by Sherwin Williams.
h. Primer: See schedule.

D. Alkyd Coating:

1. Alkyd

a. Usage: High gloss industrial enamel offering good flow, hiding and protection for recommended surfaces in mild to moderately severe exposures. Not for use on surfaces that are continually wet or sweat frequently.
b. Exposure: Mild to moderately severe.
c. Number of Coats: See schedule.
d. Finish: Gloss.
e. Minimum Solids Content: 49.0 ± 2.0%.
f. Minimum Dry Film Thickness Per Coat: See schedule.
g. Hi-Build Tneme-Gloss, Series 2H, as manufactured by Tnemec, or Industrial Enamel, as manufactured by Sherwin Williams.
h. Primer: See schedule.

2. Phenolic Alkyd

a. Usage: Lead- and chromate-free, fast-drying, corrosion-resistant primer that accepts a variety of high-performance topcoats. Ideally suited for steel fabricators, OEM's and field applications where "dry-fall" characteristics are desired. Note: Not recommended for immersion.
b. Exposure: Moderate.
c. Number of Coats: See schedule.
d. Color: 77 Red or 78 Gray.
e. Minimum Solids Content: 58.0 ± 2.0%.
f. Minimum Dry Film Thickness Per Coat: See schedule.
g. Chem-Prime H.S., Series 37H, as manufactured by Tnemec, or Kem Bond HS Primer, as manufactured by Sherwin Williams.
h. Primer: See schedule.

E. Acrylic

1. HDP Acrylic Polymer

a. Usage: Water-based, low VOC, High Dispersion Pure acrylic polymer coating providing excellent long-term protection in both interior/exterior exposures. May be applied by spray, brush or roller over a variety of solvent and waterborne steel primers. May also be used over many aged coatings. It is mildew resistant and exhibits very good gloss and color stability. Application methods include "dry-fall" under certain conditions (See Application). Note: Series 1029's "dry-fall" characteristics help reduce the potential for overspray problems on buildings and surrounding property.
b. Exposure: Moderate.
c. Number of Coats: See schedule.
d. Color: Refer to Tnemec Color Guide.
e. Minimum Solids Content: 40.0 ± 2.0%.
f. Minimum Dry Film Thickness Per Coat: See schedule.
g. Enduratone, Series 1029, as manufactured by Tnemec, or SherCryl HPA, as manufactured by Sherwin Williams.
h. Primer: See schedule.

2. Modified Waterborne Acrylate

a. Usage: Flexible, breathable coating primarily for concrete and masonry that can fill and bridge minor hairline cracks. Excellent elastomeric protection against driving rain, alternate freezing-thawing and UV light. Series 156 can also be used as a low cohesive stress overcoat for aged oil or alkyd systems.
b. Exposure: Moderate.
c. Number of Coats: See schedule.
d. Color: Refer to Tnemec Color Guide.
e. Minimum Solids Content: 50.9 ± 2.0%
f. Minimum Dry Film Thickness Per Coat: See schedule.
g. Enviro-Crete, Series 156, as manufactured by Tnemec, or ConFlex XL Smooth, as manufactured by Sherwin Williams.
h. Primer: See schedule.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for application examination.

B. Examine areas and conditions under which application of coating systems shall be performed for conditions that will adversely affect execution, permanence, or quality of coating system application.

C. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes until moisture content of surface is below following limits:

1. Masonry Surfaces: 12% maximum
2. Vertical Concrete Surfaces: 12% maximum
3. Horizontal Concrete Surfaces: 8% maximum

D. Correct conditions detrimental to timely and proper execution of Work.

E. Do not proceed until unsatisfactory conditions have been corrected.

F. Commencement of installation constitutes acceptance of conditions and responsibility for satisfactory performance.

3.2 PREPARATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for application preparation.

B. Protection:

1. Take precautionary measures to prevent fire hazards and spontaneous combustion. Remove empty containers from Site.

2. Place cotton waste, cloths and hazardous materials in containers, and remove from Site daily.
3. Provide drop cloths, shields, and other protective equipment.
4. Protect elements surrounding work of this section from damage or disfiguration.
5. As Work proceeds, promptly remove spilled, splashed, or splattered materials from surfaces.
6. During application of coating materials, post Wet Paint signs.
7. During application of solvent-based materials, post No Smoking signs.

C. Clean surfaces of loose foreign matter.

D. Remove substances that would bleed through finished coatings; if removal is not possible, seal surface with shellac.

E. Remove finish hardware, fixture covers, and accessories and store.

F. Existing Painted and Sealed Surfaces:

1. Remove loose, flaking, and peeling paint, and feather edge and sand smooth edges of chipped paint.
2. Clean with mixture of trisodium phosphate and water to remove surface grease and foreign matter.

G. Galvanized Surfaces: Remove surface contamination and oils and wash with solvent. Surfaces shall be mechanically cleaned to remove passivation and to provide a uniform 1.0 mil anchor profile.

H. Ferrous Metal:

1. Surfaces shall be free of residual deposits of grease, rust, scale, dirt, dust, and oil.

   a. Immersion Service: SSPC-SP 10 Near White Blast Cleaning
   b. Non-Immersion Service: SSCP-SP 6 Commercial Blast Cleaning.

2. Field Repair of Shop Primed Surfaces:

   a. Non-Immersion Service: Remove all dirt, dust, chalk, oil, grease, as well as any other foreign matter by solvent cleaning (SSPC-SP 1) and/or power washing. All areas damaged during transportation, construction or installation shall be cleaned in accordance with SSPC-SP 11 Power Tool Cleaning to Bare Metal or SSPC-SP 6 Commercial Blast Cleaning. All edges shall be feathered. All surfaces shall be clean and dry prior to coating
   b. Immersion Service: Remove all dirt, dust, chalk, oil, grease, as well as any other foreign matter by solvent cleaning (SSPC-SP 1) and/or power washing. All areas damaged during transportation, construction or installation shall be cleaned in accordance with SSPC-SP 10 Near White Blast Cleaning. All edges shall be feathered. The remainder of the intact shop primer shall be cleaned in accordance with SSPC-SP 7 Brush-Off Blast Cleaning to provide a minimum, uniform, anchor profile of at least 1.0 mil. In order to prevent injury to surrounding painted areas, blast cleaning may necessitate use of lower air pressure, small nozzle and abrasive particle sizes, short blast nozzle distance from surface, shielding and masking. If

damage is too extensive to touch-up, item shall be re-cleaned and coated or painted. All surfaces shall be clean and dry prior to receiving the specified finish coat(s).

3. For surfaces not shop primed, surfaces shall be cleaned in compliance with specifications of Steel Structures Painting Council as indicated in Schedule of Coating Systems below.

3.3 APPLICATION

A. Comply with MPI - Architectural Painting Manual.

B. Apply primer to each surface, unless specifically not required by coating manufacturer.

C. Apply coating systems in compliance with manufacturer's instructions and using application method best suited for obtaining full, uniform coverage of surfaces to be coated.

D. Apply primer, intermediate, and finish coats to comply with wet and dry film thickness and spreading rates for each type of material as recommended by manufacturer.

1. Application rates in excess of those recommended and fewer numbers of coats than specified shall not be accepted.

E. Number of coats specified shall be minimum number acceptable. Apply additional coats as needed to provide a smooth, even application.

1. Closely adhere to re-coat times recommended by manufacturer. Allow each coat to dry thoroughly before applying next coat. Provide adequate ventilation for tank interior to carry off solvents during drying phase.

F. Employ only application equipment that is clean, properly adjusted, and in good working order, and of type recommended by coating manufacturer.

G. After surface preparation, interior weld seams shall receive a stripe coat applied by brush.

H. Make edges of paint adjoining other materials or colors sharp and clean, without overlapping.

I. Apply coatings to specified thicknesses.

J. Apply in uniform thickness coats, without runs, drips, pinholes, brush marks, or variations in color, texture, or finish.

K. Finish edges, crevices, corners, and other changes in dimension with full coating thickness.

3.4 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.

B. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

C. Inspecting and Testing: Comply with MPI - Architectural Painting Manual.

3.5 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.

B. Collect waste material that may constitute fire hazard, place in closed metal containers, and remove daily from Site.

C. Clean surfaces immediately of overspray, splatter, and excess material.

D. After coating has cured, clean and replace finish hardware, fixtures, and fittings previously removed.

3.6 SCHEDULE

A. EXTERIOR SERVICE

*All coating thickness are expressed in dry film thickness (DFT.)

1. Non-Submerged Ductile Iron:

a. Surface Preparation: Abrasive blast to remove all contaminants.

1) Primer:

a) Tnemec: Series N140-1211 Pota-Pox Plus
b) Sherwin Williams: Macropoxy 5500 LT
c) Carboline: Carboguard 635
d) Dry Film Thickness: 6.0 – 8.0 (Carboline: 4.0 - 6.0)

2) Intermediate:

a) Tnemec: Series 66 Epoxoline **Note (1), (2)**
b) Sherwin Williams: Macropoxy 646 Fast Cure
c) Carboline: Carboguard 635
d) Dry Film Thickness: 3.0 – 5.0 (Carboline: 4.0 - 6.0)

3) Finish Coat:

a) Tnemec: Series 1095 Endura-Shield
b) Sherwin Williams: Acrolon 218 HS
c) Carboline: Carbothane 8845
d) Dry Film Thickness: 2.0 – 3.0 (Carboline: 3.0 - 5.0)

4) Total Dry Film Thickness: 11.0 – 16.0

Note (1) Series 66 may be interchanged with Series 161 when surface temperature is below 50 degrees (21degrees C) or when faster recoat is desired
Note (2) 66HS Epoxoline may be substituted for 66 Epoxoline.

B. COLOR SYSTEM MATERIAL INDENTIFICATION

1. The color system shall be selected by the Owner from manufacturer's standard color chart.

END OF SECTION 09 96 00

SECTION 09 96 10 – EPOXY LINING SYSTEM FOR CONCRETE STRUCTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Lining of concrete surfaces exposed to wastewater immersion and sewer gases, including hydrogen sulfide (H_2S), in wastewater treatment facilities and collection structures with a 100% solids epoxy lining.

B. The coating systems specified herein shall be applied to all interior and baffle walls of the existing chlorine contact chamber and the effluent launder of existing Clarifier #2.

1.2 REFERENCE STANDARDS

A. American Concrete Institute, (ACI)

1. ACI 224.1R – Causes, Evaluation and Repair of Cracks in Concrete Structures
2. ACI 301 – Specifications for Structural Concrete
3. ACI 308R – Guide to Curing Concrete
4. ACI 350 – Code Requirements for Environmental Engineering Concrete Structures and Commentary
5. ACI 515 – A Guide to the use of Waterproofing, Damp proofing, Protective, and Decorative Barrier Systems for Concrete
6. ACI 546.R – Concrete Repair Guide
7. ACI 546.3R – Guide for the Selection of Materials for the Repair of Concrete

B. ASTM International (ASTM)

1. ASTM C 413-01(2006) – Standard Test Method for Absorption of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes
2. ASTM C 868-02(2008) – Standard Test Method for Chemical Resistance of Protective Linings
3. ASTM D 870-09 – Standard Practice for Testing Water Resistance of Coatings Using Water Immersion
4. ASTM D 1653-03(2008) – Standard Test Methods for Water Vapor Transmission of Organic Coating Films
5. ASTM D 2240-05 – Standard Test Method for Rubber Property—Durometer Hardness
6. ASTM D 4060-07 – Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abrader
7. ASTM D 4541-09 – Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers

C. International Concrete Repair Institute, (ICRI)

1. Guideline No. 310.1R – Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion

2. Guideline No. 310.2 – Selecting and Specifying Concrete Surface Preparation for Sealer, Linings, and Polymer Overlays

D. NACE International (NACE)

1. NACE SP0188-2006 – Standard Practice for Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates

E. SSPC: The Society for Protective Coatings (SSPC)

1. SSPC-PA2 – Paint Application Specification No. 2: Measurement of Dry Coating Thickness with Magnetic Gages.
2. SSPC-SP13/NACE No. 6 – Surface Preparation of Concrete
3. SSPC-Guide 12 – Guide for Illumination of Industrial Painting Projects

F. Standard Practice for the Rapid Evaluation of Coatings and Linings by Severe Wastewater Analysis Test, (S.W.A.T.)

1. Corrosion Testing Laboratories, Inc., Newark, DE, USA. (www.corrosionlab.com)
2. RAE Engineering and Inspection, LTD., Edmonton, Alberta, CANADA. (www.raeengineering.ca)

1.3 PREINSTALLATION MEETINGS

A. Section 01 31 00 – Project Management and Coordination.

B. Convene minimum two weeks prior to commencing Work of this Section.

C. Schedule a conference and inspection to be held on-site before field application of coating systems begins.

D. Conference shall be attended by Contractor, Owner's Representative, Engineer, coating applicators, and a representative of coating material manufacturer.

E. Topics to be discussed at meeting shall include:

1. A review of Contract Documents and accepted shop drawings shall be made and deviations or differences shall be resolved.
2. Review items such as environmental conditions, surface conditions, surface preparation, application procedures, and protection following application.
3. Establish which areas on-site will be available for use as storage areas and working area

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data:

1. Submit manufacturer information indicating coating materials, manufacturer's name, product name, product number, performance ratings, curing times, mixing, thinning and application requirements.

    a. Provide material analysis, including vehicle type and percentage by weight and by volume of vehicle, resin and pigment.
    b. Submit manufacturer's Material Safety Data Sheets (MSDS) and other safety requirements.

C. Samples: Submit one color chart/color samples, illustrating colors for selection.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Manufacturer Instructions: Submit special procedures, perimeter conditions requiring special attention.

F. Quality Assurance Submittals:

1. Certificates:

    a. Coatings manufacturer shall certify that coating materials utilized are "non-lead" (less than 0.06% lead by weight in dried film) as defined in Part 1303 of Consumer Product Safety Act.
    b. Provide certification that specialized equipment as may be required by manufacturer for proper application of coating materials shall be utilized for work of this Section.
    c. Provide manufacturer's certification that products to be used comply with specified requirements and are suitable for intended application.

2. Manufacturer's Instructions:

    a. Submit manufacturer's installation procedures which shall be basis for accepting or rejecting actual installation procedures.

G. Qualifications Statements:

1. Submit qualifications for manufacturer and applicator.
2. Submit manufacturer's approval of applicator.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Operation and Maintenance Data: Submit maintenance and cleaning requirements for coatings, repair, and patching techniques.

1.6 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Provide products from a company specializing in the manufacture of high-performance epoxy coatings with a minimum of 10 years' experience.

1. Materials shall be products of a single manufacturer or items standard with manufacture of specified coating materials.
2. Submit manufacturer's certification that coatings comply with specified requirements and are suitable for intended application.

B. Applicator's Qualifications: Engage a single installer approved by the manufacturer with a minimum of three years' experience performing this type of lining installation and with documented skill and successful experience in the installation of 100% solids epoxy linings on concrete surfaces.

1. Submit name and qualifications to Engineer.
2. Submit proof of acceptability of applicator by manufacturer to Engineer.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Container Labeling: Include manufacturer's name, type of coating, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.

C. Inspection:

1. Accept materials on Site in manufacturer's sealed and labeled containers.
2. Inspect for damage and to verify acceptability.

D. Store materials in ventilated area and otherwise according to manufacturer instructions.

E. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.8 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. Include coverage for bond to substrate, and degradation of chemical resistance.

PART 2 - PRODUCTS

2.1 COATING

A. Manufacturers:

1. Tnemec Company, Inc.
2. Or Approved Equal.

B. Chlorine Contact Basin Coating System

1. 100% Solids Fiber-Reinforced Epoxy System

a. Surface Preparation: SSPC-SP 13/NACE No. 6 Surface Preparation of Concrete with an ICRI- CSP 5 surface profile. All surfaces clean and dry.
b. Primer/Resurfacer: Tnemec Series N218 MortarClad at 1/8" above the plane of the existing concrete. Surfacing material must be able to be applied at up to 1" in a single lift.
c. Lining: Tnemec Series G435 Perma-Glaze applied at 80.0 – 100.0 mils DFT.

C. Clarifier Launder Coating System

1. 100% Solids Fiber-Reinforced Epoxy System

a. Surface Preparation: SSPC-SP 13/NACE No. 6 Surface Preparation of Concrete with an ICRI- CSP 5 surface profile. All surfaces clean and dry.
b. Primer/Resurfacer: Tnemec Series N218 MortarClad at 1/8" above the plane of the existing concrete. Surfacing material must be able to be applied at up to 1" in a single lift.
c. Lining: Tnemec Series G435 Perma-Glaze applied at 80.0 – 100.0 mils DFT.
d. Finish Coat: Tnemec Series 690 Siloxilon applied at 5.0 – 7.0 mils DFT.

2.2 MATERIALS

A. Protective Lining shall be comprised of: 1) concrete repair mortar or epoxy resurfacer and 2) epoxy lining.

1. Epoxy Resurfacer: Epoxy-polymer modified cementitious resurfacer applied to new or existing concrete to a depth up to 1-inch. Repair new or existing concrete to fill all bugholes, surface imperfections and provide a uniform, level substrate for application of the protective lining; and
2. 100% Solids Epoxy Lining to provide chemical, permeation, and abrasion resistance against phenomena typically associated with municipal wastewater immersion and/or headspace conditions.

B. Contractor shall provide all accessory components such as polysulfide sealants, and curing compounds, as recommended by the manufacturer for maximum protective lining adhesion to substrate, and long-term service performance.

C. Epoxy cementitious resurfacer shall be an epoxy-modified, aggregate reinforced material for surfacing, patching and filling voids and bugholes in concrete. The material shall be suitable for the application from 1" down to 1/16 inch (1.6 mm) thickness and be capable of spray-transfer.

PART 3 - EXECUTION

3.1 GENERAL

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for application examination.

B. All surface preparation, coating and painting shall conform to applicable standards of the Society for Protective, NACE International, and the manufacturer's printed instructions. Material applied prior to approval of the surface by the Engineer/Owner's Agent shall be removed and reapplied to the satisfaction of the Engineer/Owner's Agent at the expense of the contractor.

C. All work shall be performed by skilled craftsmen qualified to perform the required work in a manner comparable with the best standards of practice. Continuity of personnel shall be maintained, and transfers of key personnel shall be coordinated with the Engineer/Owner's Agent.

D. The contractor shall provide a supervisor at the work site during cleaning and application operations. The supervisor shall have the authority to sign change orders, coordinate work and make decisions pertaining to the fulfillment of the contract.

E. Dust, dirt, oil, grease or any foreign matter that will affect the adhesion or durability of the finish must be removed by washing with clean rags dipped in an approved cleaning agent and wiped dry with clean rags.

F. Coating and painting systems include surface preparation, prime coating, intermediate coating, and finish coatings. Any off-site work that does not conform to this specification is subject to rejection by the Engineer/Owner's Agent.

G. The contractor's coating and painting equipment shall be designed for application of materials specified and shall be maintained in first class working condition. Compressors shall have suitable traps and filters to remove water and oils from the air. Contractor's equipment shall be subject to approval of the Engineer/Owner's Agent.

H. Prior to assembly, all surfaces made inaccessible after assembly shall be prepared as specified herein and shall receive the coating or paint system specified.

3.2 PREPARATION

A. Concrete surfaces to receive protective coating shall be cast with a Smooth Form Finish in accordance with ACI 301. Surfaces shall not be rubbed, sacked, troweled or otherwise finished in any manner that will obscure or cover the parent concrete surface with materials other than materials as specified in this Section.

B. Allow cast-in-place concrete to cure for a minimum of 28 days at 75°F (24°C) and with adequate air movement before installing the corrosion protection lining system.

C. All surface washing, abrasive blasting, waterjetting, grinding, patching, filling and preparation shall be completed by the Applicator in accordance with the Protective Coating Manufacturer's recommendations.

D. Substrate: Concrete surfaces to be coated shall be free of curing compounds and form release agents, laitance and foreign particles that may inhibit bonding. Prior to start of protective coating systems application, pre-clean as required, and inspect the substrate in accordance with SSPC-SP13/NACE No. 6, Severe Service. Surface preparation procedures shall be in accordance with NACE SP0892, SSPC-SP13/NACE No. 6 and ICRI Guideline No. 310.2. Surface preparation shall expose aggregate and obtain a uniform surface texture resembling the minimum recommended concrete surface ICRI-CSP profile.

E. Level or grind concrete substrates to produce a uniform and smooth surface, including removal of all sharp edges, ridges, form fins, and other concrete protrusions.

F. New Concrete Application: All voids, bugholes, and other surface depressions shall be filled with the specified epoxy-modified resurfacer, re-establishing plan finished grades and concrete planes. The thin overlay shall be applied as a continuous parge coat at a minimum 1/16 inch (1.6 mm) thickness to the entire concrete surface.

G. Existing Concrete Application: Existing concrete structures to receive protective coating system must be capable of withstanding imposed loads. All oil, grease, waste and chemical contaminants must be removed from the surface of the concrete prior to preparation in accordance with NACE SP0892 and SSPC-SP13/NACE No. 6. Concrete surfaces must be sound and capable of supporting the Protective Lining system as determined by the engineer. Surface preparation requirement is to expose a sound, uniform surface texture confirming to the minimum recommended ICRI-CSP. The appropriate cementitious repair mortar or epoxy cementitious resurfacer material shall be applied to the entire, prepared surface to level surface suitable for coating.

3.3 APPLICATION

A. Protective coating systems shall be installed when ambient air and surface temperature is above 50°F. The substrate temperature shall be at least 5°F (3°C) above the dew point. Condition the material between 70-80°F (21-27°C) for 24 hours prior to use. Application when temperatures outside of this range will require written instruction from the Manufacturer and approval of the Engineer.

B. Application in direct sunlight and/or with rising surface temperatures is not allowed, as this may result in blistering of the materials due to expansion of entrapped air or moisture in the concrete. In such cases, it will be necessary to postpone the application until later in the day when the temperature of the substrate is falling. Concrete surfaces that have been in direct sunlight should be shaded for at least 24 hours prior to application. Consult the Manufacturer for application schedule guidelines specific to temperature conditions and possible sealer application recommendations to reduce outgassing.

C. Epoxy Cementitious Resurfacer: Epoxy cementitious resurfacer shall be used for filling voids, bugholes, static cracks and joints, and for general concrete patching, and to provide a uniform, void free surface for Epoxy Lining application.

1. Thickness – Epoxy cementitious resurfacer shall be applied to a minimum thickness of 1/16 inch (1.6 mm) to the entire surface.

D. 100% Solids Epoxy Lining: Epoxy lining shall be applied over the epoxy cementitious surfacer in accordance with Manufacturer's written instructions as outlined in the product data sheet and application guide.

1. Thickness – Epoxy lining shall be applied to a thickness of 80.0 – 100.0 mils (2000–2,500 microns) dry film thickness over the entire epoxy cementitious mortar surface.

3.4 FIELD QUALITY CONTROL, INSPECTION AND TESTING

A. Contractor to perform the quality control procedures listed below in conjunction with the requirements of this Section.

B. Inspect all materials upon receipt to ensure that all are supplied by the approved Manufacturer.

C. Surface pH Testing: The pH of the concrete substrate sha;; be measured using pH indicating papers. The pH testing is to be performed once every 50 square feet (5 square meters). Acceptable pH values shall be a minimum 9.0 as measured using color indicating pH paper with readable color calibrations and a scale at whole numbers (minimum). Use Hydrion Insta-Check Jumbo 1-12, or equal. The paper shall be touched to the surface once using moderate gloved finger pressure. The surface shall not be wiped or moved laterally to disturb the surface during pH testing. Following the one touch, lift the paper vertically to not "wipe" the surface. Compare the color indicated with the scale provided and record the pH. Spot check any questionable areas with a 1% phenolphthalein solution. The phenolphthalein solution shall turn bright pink on concrete.

D. Surface Profile: Inspect and record substrate profile (anchor pattern). Surfaces shall be profiled, at a minimum, equal to the CSP roughness as recommended by the coating manufacturer in accordance with ICRI Guideline 310.2 and SSPC-SP13/NACE No. 6.

1. Perform replication of the concrete surface profile every 500 square feet (46 square meters) using replica putty in accordance with ASTM D7682. Submit replications to the Engineer as part of the Jobsite Reports.

E. Measure and record ambient air temperature once every two hours of each work shift using a thermometer and measure and record substrate temperature once every two hours using an infrared or other surface thermometer.

F. Measure and record relative humidity and dew point temperature every two hours of each work shift using a sling psychrometer in accordance with ASTM E 337.

G. Provide verification of correct mixing of coating materials in accordance with the Manufacturer's instructions.

H. Inspect and record that the "pot life" of coating materials is not exceeded during installation.

I. Verify curing of the coating materials in accordance with the Manufacturer's instructions.

J. Dry-Film Thickness:

1. Wet-Film Thickness shall be taken every 100 square feet (9 square meters) in accordance with ASTM D 4414 and recorded.
2. The Dry-Film Thickness can be determined using a surface area calculation for material consumption.

K. High-Voltage Holiday (Spark) Testing: Upon full cure, the installed lining system shall be checked by high voltage spark detection in accordance with NACE SP0188 and the Manufacturer’s printed application guide to verify a pinhole-free surface. Areas which do not pass the spark detection test shall be corrected at no cost to the Owner.

L. Contractor is responsible for keeping the Engineer informed of all progress so that Engineer may provide additional quality control at his discretion.

M. Inspection by the Engineer or others does not absolve the Contractor from his responsibilities for quality control inspection and testing as specified herein or as required by the Manufacturer's instructions.

3.5 ACCEPTANCE CRITERIA

A. All surfaces shall be prepared, applied, and tested in accordance with the specification and referenced standards herein.

3.6 ADJUSTMENT AND CLEANING

A. At the completion of the Work, Contractor shall remove all materials and debris associated with the Work of this Section.

B. Clean all surfaces not designated to receive protective coating. Restore all other work in a manner acceptable to Engineer.

C. All finished protective coating shall be protected from damage until Final Acceptance of the Work. Protective coating damaged in any manner shall be repaired or replaced at the discretion of Engineer, at no additional cost to Owner.

END OF SECTION 09 96 10

THIS PAGE INTENTIONALLY LEFT BLANK

JRA PROJECT NO. 224149
WASTEWATER TREATMENT PLANT
WWTP IMPROVEMENTS
WETUMPKA WWSB
WETUMPKA, ALABAMA
CLIENT JOB NO. CMGM230096
BASED ON CLIENT TEMPLATE: "A_GMC Municipal.docx"
PRINTED ON: November 6, 2024

ELECTRICAL SPECIFICATION INDEX:

11/6/2024

SECTION 26 05 00 - BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 DESCRIPTION

A. General Conditions:

1. The accompanying General Conditions (front-end specifications) shall apply to and form a part of this section.

B. General Requirements:

1. Carefully examine General Conditions, other specification sections, and other drawings (in addition to Electrical) in order to be fully acquainted with their effect on electrical work.
2. Do all work in compliance with all applicable codes, laws, and ordinances, the National Electrical Safety Code, the National Electrical Code (hereinafter referred to as "Code"), applicable energy codes, and the regulations of the local utility companies. Obtain and pay for any and all required permits, inspections, certificates of inspections and approval, and the like.
3. Cooperate with other trades and contractors at job. Perform work in such manner and at such times as not to delay work of other trades. Complete all work as soon as the structure and installations of equipment will permit. Patch, in a satisfactory manner and by the proper craft, any work damaged by electrical workmen.
4. The Owner shall be provided access to all software to include copies of software for all systems provided under this division of the specifications. Software shall be password protected where applicable.
5. Only qualified electrical sub-contractors will be allowed to submit proposals for this project. In order to be considered qualified, contractor shall have completed a minimum of five (5) projects of similar type/scope and equal or greater magnitude and complexity within the last ten (10) years. Sub-contractors without qualifications will be rejected. If desired, potential electrical sub-contractors may submit qualification evidence for review and pre-bid approval a minimum of ten (10) days prior to bid. Previous projects used to meet this experience requirement must have included similar (or greater) scopes of work for each of the following areas:

    a. Power Systems.
    b. Control Systems.
    c. Instrumentation Systems.

6. Electrical contracting firm shall be licensed as an electrical contractor in the state where work will be performed

1.2 GENERAL SCOPE OF ELECTRICAL WORK (REFER TO DRAWINGS FOR OTHER SPECIFIC SCOPE ITEMS)

A. Furnish all labor and materials to complete electrical work as shown on drawings and/or herein specified.

B. Remove all existing electrical equipment and wiring made obsolete by this project and remove or relocate all electrical services located on or crossing through the project property, either above or below grade, which would obstruct the construction of the project or conflict in any manner with the completed project or any code pertaining thereto. Dispose of salvageable materials as directed by the Engineer. Contractor shall schedule meeting to review scope of electrical demolition and to confirm scope and phasing of proposed demolition with the owner in the presence of the prime consultant prior to start of any electrical demolition.

C. Furnish and install complete power distribution system as shown on drawings and/or specified herein.

D. Furnish and install complete variable frequency drives and associated devices for motors as shown on drawings and/or specified herein.

E. Furnish and install disconnect switches for motors as shown on drawings and/or specified herein.

F. Furnish and install complete electrical grounding systems as shown on drawings and/or specified herein.

G. Install and connect electrical equipment mentioned in Division 26/27/28 Specifications or noted in drawings, whether furnished by electrical contractor or by others.

1. Where shown or specified, equipment furnished by others shall be installed and connected under this Contract.
2. Where shown or specified, Contractor shall receive, unpack, check and assume custody of equipment furnished by Others. Contractor shall assume responsibility for care and safekeeping of this equipment, when delivered into his custody. He shall protect it from moisture, dust and damage during construction and until Owner acceptance of project.

H. Furnish and install all electrical items shown on drawings and/or herein specified, unless shown or specified otherwise.

I. Furnish and install complete controls, instrumentation & auxiliary systems as shown on drawings and/or specified herein.

J. Procure and pay for permits and certificates as required by local and state ordinances and fire underwriter's certificate of inspection.

K. Balance loads as equally as practicable on services, distribution feeders, circuits and buses. Provide typewritten directory for each panel.

L. Unless specifically indicated or required otherwise, terminate all circuitry/cabling provided within this contract at associated equipment/devices/etc. in accordance with all applicable codes, standards and supplier requirements, whether associated equipment/device/etc. is furnished within this contract or by others.

M. Complete field testing, adjustment & startup of all systems listed above as shown on drawings and/or specified herein.

PART 2 - PRODUCTS

2.1 APPROVED MATERIALS AND DEVICES

A. Where not otherwise specified, provide only new, standard, first-grade materials/systems throughout, conforming to standards established by Underwriter's Laboratories, Inc., and so marked or labeled, together with manufacturer's brand or trademark. All equipment/systems subject to approval of Engineer before installation. All like items and associated equipment/systems shall be of one manufacturer.

B. To ensure proper coordination, it is intended that all electrical equipment and materials specified in Division 26/27/28 of these specifications and shown on the electrical drawings be furnished and installed by the electrical sub-contractor. It will not be permissible for any of these items to be furnished directly by the general contractor without the electrical contractor's coordination.

C. To ensure commonality of spare parts, it is required that the electrical contractor provide the same brand for all circuit breakers, starters, power equipment, etc. provided under the following divisions of these specifications:

1. SECTION 26 24 19: MOTOR CONTROL CENTERS
2. SECTION 26 28 16: SAFETY SWITCHES AND FUSES

2.2 SUBMITTALS

A. All submittals to the design team shall be accompanied by a letter summarizing all proposed deviations from specified products or pre-approved substitutions. The absence of such a letter shall be understood to indicate that the contractor intends to meet all contract requirements, regardless of cut-sheets/data-sheets provided within the submittal.

B. Submit to Engineer ten (10) days prior to bid date three (3) copies of any items and/or manufacturers which are proposed as substitutes for those specified.

C. Submit to Engineer promptly after award of Contract and prior to purchasing, the number of copies required by the contract. All drawings of a specific item or system shall be made in one submittal, and within thirty (30) days after award of Contract. Shop drawings of all power equipment shall contain exact details of device placement, phasing and numbering, in form of elevations, for each major piece of equipment. Shop drawings shall be submitted on the following:

1. SECTION 26 24 19: MOTOR CONTROL CENTERS
2. SECTION 26 28 16: SAFETY SWITCHES AND FUSES
3. SECTION 26 29 00: MANUFACTURED CONTROL PANELS
4. SECTION 26 29 16: REDUCED VOLTAGE SOFT STARTERS

5. SECTION 26 44 00: ELECTRICAL HEAT TRACING SYSTEMS
6. SECTION 27 60 00: SCADA SYSTEM
7. SECTION 27 60 05: INSTRUMENTATION
8. ALL POWER DISTRIBUTION EQUIPMENT (i.e. SWITCHBOARDS, PANELBOARDS, DRY TYPE TRANSFORMER, ETC.)
9. ALL ELECTRICAL AND TELECOMMUNICATION EQUIPMENT LAYOUTS - Submittals shall include ¼" = 1'-0" CAD drawings (hand drawn sketches will not be accepted) of each electrical room, IT room, electrical equipment stand, generator area, or any other similar area with electrical equipment. Drawings shall indicate all panelboards, transformers, switchboards, generators, equipment racks, control panels, HVAC equipment, etc. that are located in each electrical/IT area. Layouts shall show that each piece of electrical equipment has the clearances, working space and dedicated equipment space required by applicable codes. No conduits to equipment within these areas shall be installed until submittals have been provided and returned without exception by the design team.
10. ALL CONTROL ITEMS & SYSTEMS

D. The contractor shall fully review, comment upon and correct all shop drawings as required to assure compliance with contract documents prior to submittal to Engineer. The failure of the contractor to properly review and correct shop drawings prior to submittal will result in rejection of shop drawings by the engineer. Review by the Engineer will be for general conformance with contract documents. The contractor shall be fully responsible for correctness of all submitted dimensions, details, quantities and locations.

E. None of the above items shall be installed until shop drawings or catalog data have been reviewed by Engineer without rejection or required resubmittal. Any listed item not submitted, even if specified, shall be considered not acceptable and shall be removed if directed.

F. Any required resubmittal will be reviewed by the Engineer for conformance with previously issued comments only. The contractor shall be responsible for verifying that all items not specifically requiring resubmittal have not been altered from the previously reviewed submittal.

G. Material proposed for substitution shall be of the same quality, perform the same functions, conform to such physical dimensions and appearance as are required by the Engineer. All material proposed for substitution is subject to the approval of the Engineer and his authority for approval is final. No material proposed for substitution will be considered unless all submittal data complies with the drawings and specifications of Section 16 as to time of submission, number of copies of submittal, and detail requirements.

H. Samples of material shall be furnished where required by drawings or Division 26/27/28 Specification, or as requested by the Engineer on items proposed as substitutes.

I. Submit to Engineer a certificate of final inspection from local inspection department.

PART 3 - EXECUTION

3.1 SITE VISIT

A. The Contractor shall visit the site to determine existing dimensions and conditions affecting electrical work. Failure to do so in no way relieves Contractor of his responsibility under Contract.

3.2 WORKMANSHIP

A. All work shall be in accordance with the latest editions of NFPA 70 (National Electrical Code), NFPA 101 (Life Safety Code), National Electric Safety Code, International Building Code, applicable NECA standards and the rules and regulations of State and Local Authorities Having Jurisdiction.

B. All work shall be executed in a workmanlike manner and shall present a neat and mechanical appearance upon completion.

C. All equipment, devices, etc. shall be installed in accordance with manufacturer's recommendations.

D. All items shall be installed straight and plumb in a workmanlike manner and care shall be exercised so that like items are mounted the same position, heights and general location.

E. Keep site clean of accumulation of cartons, trash and debris.

3.3 SAFETY

A. The contractor is solely responsible for all job safety. Engineer assumes no responsibility for job safety. Maximum consideration shall be given to job safety and only such methods as will reasonably ensure the safety of all persons shall be employed. The codes and regulations of OSHA shall be given strict compliance as well as such other codes, laws, and regulations as may be applicable.

3.4 CONTRACT DOCUMENTS

A. Contract documents indicate diagrammatically, extent, general character and approximate location of work. Where work is indicated but minor details omitted, furnish and install it complete so as to perform its intended functions. For details and mechanical equipment, follow drawings provided by other disciplines (Architectural, Mechanical, Structural, Civil, etc.) and fit electrical work thereto.

B. Contract documents consist only of the hardcopy documents issued by the Prime Engineer. Electronic documents issued directly by the electrical engineer to the contractor and/or its sub-contractors/vendors are issued for convenience only (electronic documents are not formal contract documents).

C. If the contractor and/or one of its suppliers require a one-time transfer of electronic files of the current electrical construction documents to prepare shop drawings (or for another similar purpose), it shall:

1. Sign a waiver prepared by the electrical engineer prior to the transmittal of these files.
2. Agree to pay the electrical engineer a fee of $50.00 per drawing, up to a maximum of $400 per transfer, payable upon receipt of the files.
3. To the fullest extent permitted by law, indemnify, hold harmless, and defend JRA from all claims, damages, losses and expenses, including attorneys' fees arising out of or resulting from the use of the CAD files.

D. Take finish dimensions at job in preference to scaled dimensions.

E. Except as above noted, make no changes in or deviations from work as shown or specified except on written order of Engineer.

3.5 UNDERGROUND UTILITY/EQUIPMENT COORDINATION

A. Prior to commencement of work, verify exact locations of all existing or proposed underground utilities and/or underground equipment and verify that proposed electrical installation does not conflict with these items. Notify Engineer immediately if any conflict is found.

3.6 EQUIPMENT STORAGE

A. Store all electrical equipment in dry, covered locations as directed by equipment manufacturers. Contractor shall be responsible for replacing or repairing improperly-stored equipment as directed by Engineer.

3.7 EXCAVATION, CUTTING AND PATCHING

A. Perform all cutting and excavating as necessary for installation of electrical systems, unless specifically covered under another section. After Engineer's observation, complete all excavation, filling and backfilling as directed under specifications for preparation of site and earthwork. Foundations for equipment shall be as specified under concrete section. Concrete pads shall be minimum of 6" thick; unless greater thickness required by equipment manufacturer. Obtain specific approval of Engineer before cutting into any structural members.

B. For all such work employ competent workmen, and finish up in neat and workmanlike manner, equal to quality and appearance to adjacent work.

3.8 PENETRATIONS

A. All penetrations in water tight barriers shall be made so that barrier rating is not compromised. Furnish roof flashing for all equipment installed under Division 26/27/28 that penetrates through the roof. Appropriate flashing is specified under roofing and sheet metal section. Supply these flashings for installation under roofing and sheet metal section.

B. All fire/smoke barrier penetrations shall be made in accordance with a U.L. listed assembly to maintain the fire/smoke rating of the associated membrane.

C. Where penetrations are required through structural elements, verify penetration locations and sizes with structural engineer. In no case shall the structural integrity be compromised without written approval from structural engineer.

3.9 INSTALLATION OF EQUIPMENT - GENERAL

A. Care shall be exercised in exact routing and location of all items so as not to obstruct access to equipment, personnel walkways, or expose it to potential mechanical damage.

B. Items shall be securely anchored and/or fastened. Provide proper support for all equipment, devices, conduits, boxes, panels, etc. as required by code and for a workmanlike installation. Provide guy wiring for wood poles where required to prevent leaning. All construction shall meet the seismic design requirements of the building code. Items (especially transformers, light fixtures, equipment racks, freestanding gear, etc.) installed in seismic zones C, D, E or F shall be supported and braced per applicable codes and standards.

C. All wall, pole or frame-mounted electrical equipment shall be mounted to metal unistrut (or similar) frames of same material as electrical equipment. For example, pole-mounted stainless steel disconnect switches shall be mounted to stainless steel unistrut frames.

D. All electrical equipment, furnished by Contractor or by others shall be covered and protected during construction.

E. All control cabinets, panels, motor control centers and other electrical cabinets and enclosures shall have all trash removed and be vacuumed clean. All foreign paint, etc., shall be removed from exterior and all scratches in finish touched up with same color and material as original. Any rusted areas shall be sanded, primed and repainted.

F. All relays, starters, push-button and other control devices shall be cleaned and if necessary, lubricated with CRC 2-26 to assure free operation.

3.10 MOTORS, STARTERS AND CONTROLS

A. Unless otherwise specified or shown, all motors will be furnished and installed under other sections of this specification.

B. Electrical Contractor shall install all starters and all electrical power wiring and connections to motors and starters.

C. Unless otherwise specified or shown, all control items for motors shall be furnished, installed and wired in conduit by the electrician.

3.11 CIRCUITS AND BRANCH CIRCUITS

A. Outlets shall be connected to branch circuits as indicated on drawings by circuit numbers. No more outlets than are indicated shall be connected to a circuit.

B. Branch circuit homeruns shall be installed as shown on drawings. Multiple homerun conduits shall not be combined by contractor into larger, single homerun conduits unless specific permission is granted by the Engineer.

3.12 LUG/TERMINAL RATINGS

A. All lug/terminal ratings, sizes, locations, types, etc. shall be coordinated with the associated conductor sizes, types, routings, etc. by the contractor.

B. All lugs/terminals/etc. shall be rated for 75 degree C terminations (minimum, unless specified otherwise).

3.13 EQUIPMENT FAULT CURRENT RATINGS

A. All equipment and breakers shall meet the minimum RMS symmetrical interrupting capacity ratings shown on plans for the associated distribution equipment. All interrupting ratings shall be full ratings. Where new devices or breakers are added to existing distribution equipment, the new devices/breakers shall have interrupting ratings matching or exceeding that of the existing distribution equipment.

3.14 OUTLET LOCATION

A. Symbols shown on drawings and mounting heights indicated on drawings and in specifications are approximate only. The exact locations and mounting height must be determined on the job and it shall be the Contractor's responsibility to coordinate with other trades to ensure correct installation.

3.15 IDENTIFICATION

A. Each panel shall have each circuit identified. Panels without branch circuit nameplates shall have typewritten directories.

B. Each individually mounted switch, circuit breaker, starter and/or any other control or protective device shall identify equipment fed and fuse size, if any, by engraved plastic nameplate, white with black letters, screw attached.

C. See Specification Section 26 05 53 for additional requirements.

3.16 GROUNDING

A. All equipment shall be grounded and bonded in accordance with all state/local regulations, The National Electrical Code and as specified herein.

3.17 PAINTING

A. Refer to Painting/Finishing specifications for requirements regarding field painting of exposed conduit. Any scratches, dents or rust spots in conduit electrical enclosures, panels, motor control or any other electrical items shall have the dents removed, and they, along with any rust spots or scratches, sanded and touched up with the same exact color paint as original finish.

3.18 ACCEPTANCE TESTING

A. Upon completion of work, the entire electrical system installed within this project shall be tested and shall be shown to be in perfect working condition, in accordance with the intent of the specifications and drawings. It shall be the responsibility of the Electrical Contractor to have all systems ready for operation and to have an electrician available to operate same in accordance with and under the supervision of the observation representative(s) of the Engineer. The Electrician shall be available to assist in removal of panel fronts, etc., to permit inspection as required.

B. The electrical sub-contractor shall include in bid price start-up assistance and training from a certified representative of the manufacturer for the following systems:

1. SECTION 26 29 16: REDUCED VOLTAGE SOFT STARTERS
2. SECTION 26 44 00: ELECTRICAL HEAT TRACING SYSTEMS
3. SECTION 27 60 00: SCADA SYSTEM
4. SECTION 27 60 05: SCADA INSTRUMENTATION

3.19 OPERATION AND MAINTENANCE DATA

A. One set of marked “AS BUILT” drawings, three (3) sets of all equipment catalog and maintenance data and three (3) sets of all final shop drawings, on all equipment requiring same shall be turned over to owner. These items shall be bound in hard back book. Contractor shall explain and demonstrate all systems to Owner’s representative.

3.20 GUARANTY-WARRANTY

A. Furnish a written Guarantee-Warranty, countersigned and guaranteed by General Contractor, stating:

1. That all work executed under this section will be free from defects of workmanship and materials for a period of one (1) year from date of final acceptance of this work.
2. Above parties further agree that they will, at their own expense, repair and replace all such defective work, and all other work damaged thereby, which becomes defective during the term of the Guaranty-Warranty.

END OF SECTION 26 05 00

SECTION 26 05 19 - POWER CONDUCTORS AND CABLES 51V-600V

PART 1 - GENERAL

1.1 DESCRIPTION

A. Power Wires and Cables

B. Low Voltage Wires and Cables

PART 2 - PRODUCTS

2.1 POWER WIRES AND CABLES - 600 VOLT

A. General: Conductors shall have current carrying capacities as per N.E.C. and with 600 volt insulation, #12 minimum except for controls and fixture wire. Conductors shall be copper.

B. General Application (see below for exceptions):

1. At or Below Grade (including within slab-on-grade):

a. #8 or larger conductors:

1) XHHW or RHH/RHW/USE stranded (in conduit).

b. #10 or smaller conductors for circuits terminating at motors:

1) THHN/THWN or XHHW stranded (in conduit).

c. #10 or smaller conductors (excluding circuits terminating at motors):

1) THHN/THWN or XHHW solid (in conduit).

2. Above Grade:

a. #8 or larger conductors:

1) THHN/THWN, XHHW or RHH/RHW/USE stranded (in conduit).

b. #10 or smaller conductors for circuits terminating at motors:

1) THHN/THWN, XHHW or RHH/RHW/USE stranded (in conduit).

c. #10 or smaller conductors (excluding circuits terminating at motors):

1) THHN/THWN, XHHW or RHH/RHW/USE solid (in conduit).

3. Power Wire and cable shall be as manufactured by Southwire, Rome, Encore Wire, American Insulated Wire, Okonite, Phelps-Dodge, Amercable, Aetna or approved equal.

C. VFD Cabling

1. Wiring/Cabling installed between each VFD (Variable Frequency Drive) and the associated motor shall be multi-conductor shielded VFD power cable with the following characteristics:

   a. Multi-conductor cable with three (3) power conductors and three (3) ground conductors
   b. Soft annealed flexible stranded copper conductors.
   c. 1kV cross-linked polyolefin insulation (to resist the potential reflected voltages experienced in 600VAC VFD applications).
   d. Metallic shielded providing 100% shield coverage
   e. Oil, abrasion, chemical & sunlight resistant thermosetting compound outer jacket.
   f. Flexible TC-ER rated, UL listed for use in cable trays.
   g. Equal to AmerCable #37-108VFD cable.

D. Class 1 Control Cabling (120VAC Control Circuits, Etc.)

1. Unless specified otherwise, Class 1 control cabling shall:

   a. Be rated for exposed cable tray installation.
   b. Be plenum rated (Class 1 Control cabling and Instrumentation cabling installed in conduit or exposed in cable tray in non-plenum areas is not required to be plenum-rated).
   c. Be UL-rated for the proposed application.
   d. Be multi-conductor with overall outer sheath as required by the application. The insulation of each conductor within the overall multi-conductor cable shall be uniquely color-coded. Ground conductors (when provided) within the multi-conductor cable shall have green insulation. Conductors with green insulation shall not be used for conductors other than ground.
   e. Utilize copper conductors.
   f. Have wire gauge as required to limit voltage drop to acceptable limits determined by the system supplier and to meet all applicable code requirements.
   g. Where installed underground, within slab-on-grade or in exterior locations, be rated for wet locations.
   h. Where required for specific systems, meet the specific requirements (conductor quantity, wire gauge, insulation type, shielding, etc.) of the system supplier.
   i. Be rated for 600V.
   j. Be industrial grade.
   k. Have stranded conductors.
   l. Have sunlight/oil-resistant PVC/Nylon insulation and jacket with ripcord.

2. Control cabling shall be as manufactured by Belden, AlphaWire or General Cable.

2.2 WIRE CONNECTIONS:

A. All connector types:

1. Shall be properly rated for the proposed application by UL and per the manufacturer.

B. At Motor Connections (within motor terminal boxes):

1. On Unshielded Wire:

a. Single conductor per phase: shall be made with insulated set screw connectors or 3M 5300 Series 1kV Motor Lead Connections kits with mechanical lugs as required.
b. Multiple conductors per phase: shall be made with insulated mechanical lugs, rated for the associated motor cable types, by Polaris or Ilsco.

2. On Shielded Power Wire:

a. The braided shields and internal grounding conductors of shielded power (not instrumentation) cables shall be grounded at BOTH ends (at VFD/starter and at motor) with a termination kit provided by the cable supplier. This termination kit shall include a connection ring that makes contact around the full circumference of the braided shield, and connects all internal grounds to a common external ground point.

C. Other Dry locations:

1. On Wire larger than #10: shall be made with solderless, non-insulated compression-type connectors meeting requirements of Federal Specification WS-610e for Type II, Class 2 and shall be covered with Scotch #33 electrical tape so that insulation is equal to 150% of conductor insulation.
2. On Wire #10 and smaller: shall be made with one of the following:

a. Ideal Wing Nuts or equal by 3M .
b. Ideal Push-In Wire Connectors (for #12 and smaller only).

D. Other Wet/Damp locations:

1. On Wire larger than #10: shall be made with underground/direct-burial, waterproof rated EPDM or TPE-insulated connectors by Ilsco, Burndy or T&B.
2. On Wire #10 and smaller: shall be made with one of the following:

a. Ideal Weatherproof or Underground Wire Connectors pre-filled with 100% silicone sealant as required by the application.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. All wires and cables shall be installed in conduit unless specifically noted otherwise.

B. All joints and splices on wire shall be made with solderless connectors, and covered so that insulation is equal to conductor insulation.

C. No splices shall be pulled into conduit.

D. No conductor shall be pulled until conduit is cleaned of all foreign matter.

E. Wire and cable shall be neatly formed, bundled and tied in all panelboards, wireways, disconnect switches, pullboxes, junction boxes, cabinets and other similar electrical enclosures.

F. All wires and cables installed in underground or other wet locations shall be rated by the manufacturer for wet locations.

G. Network cabling shall be continuous from endpoint to endpoint and shall not be spliced unless specifically noted otherwise.

H. All conductors/cabling (including spare conductors) shall be properly terminated unless specifically directed otherwise. See above for general termination hardware requirements.

3.2 POWER WIRE AND CABLE INSTALLATION:

A. No power conductor shall be smaller than #12 except where so designated on the drawings or hereinafter specified.

B. Multi-wire lighting branches shall be used as indicated.

C. Where more than three current-carrying conductors are installed in a single raceway or cable, conductors shall be derated as indicated in NEC Table 310.15(B)(3)(a).

D. Raceways/cables shall generally not be installed exposed to sunlight on roofs unless specifically required. Where raceways or cables are installed exposed to sunlight on roofs, conductors shall be derated with ampacities adjusted per NEC Table 310.15(B)(3)(c).

E. In installing parallel power conductors, it is mandatory that all conductors making up the feeder be exactly the same length, the same size, the same type of conductor with the same insulation. Each group of conductors making up a phase or neutral must be bonded at both ends in an approved manner.

F. In installing overhead main power services, a minimum of 5’-0” of cable per run shall be extended beyond the weatherhead(s) for connection to service drop. Confirm exact requirements with local utility company.

3.3 WIRE CONNECTIONS

A. See Part 2 above for material types.

B. Aluminum Wire Connections:

1. Where aluminum wiring is allowed, connections shall utilize compression fittings, no exceptions (Anderson Versa Crimp or equal).

C. Any stranded wire connection to wiring devices shall be made with crimp type terminals.

D. All electrical connections and terminals shall be tightened according to manufacturer's published torque-tightening values with calibrated torque wrenches as required to clearly indicate final torque value to the contractor. Where manufacturer's torque values are not provided, those specified in UL 486A & 486B shall be used.

E. All connections and connector types shall be installed in strict compliance with all requirements of the connector manufacturer.

F. Under no condition shall the specified conductors be connected to terminals rated less than 75°C. Where conductors sized #1 or smaller are shown to be terminated at equipment and the terminals of that equipment are rated for less than 75°C, contractor shall install junction box near equipment to capture the specified conductors, splice with compression connections (rated for a least 75°C) and extend conductors with ampacity rating as required by NEC (based on terminal temperature rating) to equipment terminals. The length of the conductors to be terminated shall be as directed by the AHJ but not less than 48 inches.

3.4 SHIELDED CABLE INSTALLATION

A. Shielded VFD (power) cables:

1. The braided shields and internal grounding conductors of shielded VFD (power) cables shall be grounded at BOTH ends (at VFD and at motor) with a termination kit provided by the cable supplier. This termination kit shall include a connection ring that makes contact around the full circumference of the braided shield, and connects all internal grounds to a common external ground point.
2. Contractor shall coordinate the necessary size of conduit with the outer diameter of the proposed cable type to verify that the raceway loading does not exceed NEC requirements prior to rough-in of the conduit system.

B. Shielded instrumentation (low voltage) cables:

1. The outer foil of shielded instrumentation cables shall be grounded at the PLC/control panel end only (not at the field device end) with a termination kit as directed by the PLC/control panel supplier.

3.5 LOW VOLTAGE (LESS THAN 50V) CONTROL AND NETWORK CABLE INSTALLATION:

A. All wires and cables shall be installed in conduit unless specifically noted otherwise. Low voltage control and/or network cabling located within concealed, accessible ceiling spaces (such as above lay-in ceilings) may be run without conduit if the following requirements are met:

1. Cabling shall be plenum-rated, multi-conductor.

2. Cabling shall be supported by cable tray or with J-hook supports on intervals not to exceed 5'-0" on center. Cabling shall be supported solely from the cable tray or j-hooks supported from the building structure, without using piping, ductwork, conduit or other items as supports.
3. Cabling shall be properly bundled with plenum-rated Velcro straps on intervals not to exceed 30" on center.
4. Properly-sized conduit(s) shall be provided wherever cabling enters an inaccessible or exposed area (such as above gyp board ceilings or through walls). End bushings shall be provided on both ends of all raceway terminations. All fire/smoke barrier penetrations shall be made in accordance with a U.L. listed assembly.

3.6 CIRCUITS AND BRANCH CIRCUITS

A. Outlets shall be connected to branch circuits as indicated on drawings by circuit number adjacent to outlet symbols, and no more outlets than are indicated shall be connected to a circuit.

3.7 LABELING AND COLOR CODING OF WIRE AND CABLE

A. Refer to Specification Section 26 05 53 for all labeling requirements.

B. A color coding system as listed below shall be followed throughout the network of branch power circuits as follows:

PHASE	120/208/240/ COLOR	120/240 HIGH LEG DELTA COLOR	277/480 VOLT COLOR
A	BLACK	BLACK	BROWN
B	RED	ORANGE (FOR HI-LEG)	ORANGE
C	BLUE	BLUE	YELLOW
NEUTRAL	WHITE	WHITE	GRAY
GROUND	GREEN	GREEN	GREEN

C. Where dedicated neutrals are installed for multi-wire branch circuits, the neutral conductors shall be color coded as follows:

PHASE	120/208/240/ COLOR	120/240 HIGH LEG DELTA COLOR	277/480 VOLT COLOR
NEUTRAL A	WHITE W/ BLACK TRACER	WHITE W/ BLACK TRACER	GRAY W/ BROWN TRACER
NEUTRAL B	WHITE W/ RED TRACER	WHITE W/ ORANGE TRACER (FOR HI-LEG NEUTRAL)	GRAY W/ ORANGE TRACER
NEUTRAL C	WHITE W/ BLUE TRACER	WHITE W/ BLUE TRACER	GRAY W/ YELLOW TRACER

D. Control Conductors: Shall be color coded by use of colored "tracers". No control circuit shall contain two identical conductors. For example, a set of five (5) control conductors for a pushbutton station represents one (1) control circuit which would require five (5) uniquely-colored control conductors.

3.8 TESTING

A. The insulation resistance of all feeder conductors (feeding electrical distribution equipment such as switchboards, panelboards, transfer switches, transformers, etc.) shall be tested at the load side of the feeder breaker with a 1000-volt DC Megger Tester prior to energization or final termination. Any feeder conductor with an insulation resistance less than the recommended minimums in the latest version of NETA Acceptance Testing Specification ("ATS") standard shall be replaced by the contractor at the contractor's expense. All final test results shall be clearly documented (with date, time, feeder, results, test equipment, etc.), and the final test results shall be submitted to the design team for review.

END OF SECTION 26 05 19

SECTION 26 05 26 - GROUNDING

PART 1 - GENERAL

1.1 GENERAL

A. THE WORK UNDER THIS SECTION INCLUDES BUT IS NOT LIMITED TO GROUNDING OF THE FOLLOWING:

1. Service Equipment.
2. Transformers.
3. Non-current carrying conductive surfaces of equipment.
4. Metal Buildings.
5. Structures.
6. Other Equipment.

1.2 GENERAL REQUIREMENTS

A. All equipment, building steel, and main service shall be effectively and permanently grounded with a conductor cross section as required by the National Electrical Code and of capacity sufficient to ensure continued effectiveness of the ground connections for fault current. Ground conductors shall be as short and straight as possible, protected from mechanical injury and, if practicable, without splice or joint.

B. All grounding connections shall be installed in accordance with the National Electrical Code and all local codes and requirements. Such codes shall be considered minimum requirements and the installation of the grounding system shall ensure freedom from dangerous shock voltage exposure and provide a low impedance ground fault path to permit proper operation of overcurrent and ground fault protective devices.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. All grounding conductors shall be insulated with green colored, 600 volt insulation unless noted otherwise.

B. Motors having power supplied by single conductor wire in conduit shall be grounded through the conduit system. Flexible conduit shall be “jumpered” by an appropriate bonding conductor.

C. Supplemental grounding system conductors shall be bare, softdrawn, stranded, single conductor copper wire, and generally sized as follows (unless shown otherwise on plans):

1. Switchgear, motor control centers, and power transformer #4/0 minimum or as shown on plans.

2. Power panels, #2/0.
3. Control panels and consoles, #4.
4. Process Motors, #1/0.
5. Building Columns, #4/0.
6. Light Poles, #2.
7. Telephone Backboard & Cabinet ground busses, #2.

2.2 GROUNDING ELECTRODES

A. Grounding electrodes shall be copper-clad steel rods 3/4 inch in diameter and ten feet long. Where longer electrodes are necessary to reduce the ground resistance, Contractor shall provide sectional rods, connectors, drive heads, etc.

2.3 CONNECTIONS

A. All conductor-to-conductor, conductor-to-ground rod, conductor-to-structure, conductor-to-fence connections of #6 and larger sized conductors and underground ground connections shall be permanent exothermic welded connections (Cadweld or equal) unless otherwise noted on applicable drawings.

B. Connections to equipment shall be by bolted compression type lugs (except for motors). When the conductor is #6 and larger, the lug shall be joined to the conductor by an exothermic weld (Cadweld or equal).

C. Motors to be grounded by the grounding conductors run with the power conductors shall have a split-post grounding stud installed in the connection box.

D. Each cast pull box or junction box shall have a ground lug, connected to largest ground conductor to enter box.

E. Ground connections at conduit terminations shall be made by approved grounding bushings (see Raceways Specification Section for additional requirements).

2.4 MANUFACTURERS

A. Conduit clamps and connectors shall be manufactured by Raco, OZ., or Ercon.

B. Lugs shall be as manufactured by Square “D”, Burndy, or T and B.

C. Exothermic weld connections shall be as manufactured by Cadweld, or approved equal.

D. Ground rods shall be as manufactured by Joslyn or McGraw Edison.

E. Split post grounding shall be as manufactured by Burndy or T and B.

PART 3 - EXECUTION

3.1 MAIN SERVICE GROUND

A. The main service grounding electrode system shall consist of the following items bonded together by the grounding electrode conductor:

1. The main underground cold water pipe (metal).
2. The metal frame of the building.
3. Driven ground rods. Ground rods shall be embedded at the lowest point in the building and below the permanent moisture level. Ground rods shall be spaced a minimum of ten (10) feet apart and connected in parallel until resistance to ground does not exceed five (5) ohms.

B. The grounding electrode system shall be connected to the grounded conductor (neutral) on the supply side of the service disconnecting means by a grounding electrode conductor not smaller than that shown in Table 250.66 of the N.E.C. The main service equipment grounding conductor shall be connected to the grounding conductor on the supply side of the service disconnecting means in accordance with Table 250.122 of the N.E.C. for the ampere rating of the service entrance equipment. Where in a service entrance switchboard, the equipment grounding conductor shall not be less than 25% of the main bus rating. These connections shall be made inside the service entrance equipment enclosure.

3.2 TRANSFORMER GROUNDS

A. Dry type insulation transformers with a grounded conductor in the secondary shall be grounded in accordance with N.E.C. Section 250-30.

3.3 EXPOSED NON-CURRENT-CARRYING METAL PARTS

A. General: Ground connections to equipment or devices shall be made as close to the current carrying parts as possible, that is, to the main frame rather than supporting structures, bases or shields. Grounding connections shall be made only to dry surfaces that are clean and dry. Steel surfaces shall be ground or filed to remove all scales, rust, grease, and dirt. Copper and galvanized steel shall be cleaned to remove oxide before making welds or connections. Code size ground conductors shall be run in all power conduits and properly terminated at each end.

B. Ground conductors shall be routed as straight as possible. Where possible, ground conductors shall be routed such as to avoid bends exceeding 90 degrees or with a radius of less than 8”.

C. Motors: Exposed non-current-carrying metal parts, shall be grounded by a grounding conductor either run with power conductors, and/or separate grounding conductors. Drawings will show method(s) to be used. The ground conductors with all motor conductors shall be connected to the ground buss in the motor connection box. Jumper connections shall be installed between frames and rigid conduit for equipment having flexible conduit connections (sealtight). All AC motor grounds shall provide a low impedance path to ground. Connections from the supplemental grounding system (when specified) shall be made directly to the motor frame. Additionally, utilization equipment connected to the motor (pump, fan, mixer, etc.) shall be bonded to the motor with flexible braid-type bonding strap to ensure equalization of ground potentials.

D. Raceways & boxes: All raceways, conduits, armored or shielded cable and all exposed non-current carrying metal parts shall be grounded. Such items shall be bonded together and permanently grounded to the equipment ground buss. Metallic conduits shall be connected by grounding or clamps to ground buss. Flexible "jumpers" shall be provided around all raceway expansion joints. Bonding straps for steel conduit shall be copper. Jumper connections shall be provided to effectively ground all sections or rigid conduit connected into plastic pipe. No metallic conduit shall be left ungrounded. In conduit systems interrupted by junction or switch boxes where locknuts and bushings are used to secure the conduit in the box, the sections of conduit and box must be bonded together. If conduit, couplings or fittings have a protective coating or non-conductive material, such as enamel, such coating must be thoroughly removed from threads of both couplings and conduit and the surface of conduit or fitting where the ground clamp is secured.

E. Enclosures: Metal conduits entering free standing motor control centers, switchboards or other free standing equipment shall be grounded by bare conductors and approved clamp. Any conduits entering low voltage (480 volts or below) equipment through sheet metal enclosure and effectively grounded to enclosure by double locknut or hub need not be otherwise bonded.

F. Equipment: In addition to equipment grounding provisions mandated by code requirements, additional equipment grounding provisions (including local ground rods, connections, etc.) shall be provided by the contractor as directed by equipment suppliers.

G. Both ends of ground busses in motor control centers, switchboards, etc., shall be separately connected to the main ground buss to form two separate paths to ground.

H. Fences and Grills: Fences and metal grills around equipment carrying voltage above 500 volts between phases shall be bonded together and to ground. Fences and grill work shall be grounded at every post, column, or support, and on each side of every gate.

3.4 ACCEPTANCE DOCUMENTATION AND TESTING

A. Contractor shall take and store photographs of all underground grounding system connections prior to burial of connections, for review by Engineer.

B. Upon completion of work, the entire ground system shall be shown to be in perfect working condition, in accordance with the intent of the Specifications.

C. Contractor shall measure the resistance between the main ground bonding jumper to true earth ground using the Fall of Potential method as described by ANSI/IEEE Standard 81 ("Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of an Earth System"). If the measured value is greater than five ohms, additional grounding electrodes shall be installed as described in Part 3.1 above. The final ground resistance value shall be submitted in writing, and documented via picture of the meter reading from the Fall of Potential test, to the Engineer prior to the final observation, and shall be included in final O&M documentation.

END OF SECTION 26 05 26

SECTION 26 05 33 - RACEWAYS

PART 1 - GENERAL

1.1 DESCRIPTION

A. THE WORK UNDER THIS SECTION INCLUDES BUT IS NOT LIMITED TO THE FOLLOWING:

1. Conduits
2. Conduit Fittings
3. Couplings & Connectors
4. Bushings
5. Raceway Hardware, Conduit Clamps & Supports
6. Watertight Entrance Seal Devices

PART 2 - PRODUCTS

2.1 CONDUITS

A. PVC-Coated Rigid Steel:

1. The PVC coated rigid metal conduit must be UL Listed. Hazardous location fittings, prior to plastic coating must be UL listed. All conduit and fittings must be new, unused material. Applicable UL standards may include: UL 6 Standard for Safety, Rigid Metal Conduit, UL514B Standard for Safety, Fittings for Conduit and Outlet Boxes.
2. The PVC-coated rigid metal conduit shall be ETL PVC-001 listed.
3. The conduit shall be hot dip galvanized inside and out with hot galvanized threads.
4. Form 8 Condulets®, 3/4" through 2" diameters, shall have a tongue-in-groove “V-Seal" gasket to effectively seal against the elements. The design shall be equipped with a positive placement feature to ease and assure proper installation. Certified results confirming seal performance at 15 psig (positive) and 25 in. of mercury (vacuum) for 72 hours shall be available.
5. A PVC sleeve extending one pipe diameter or two inches, whichever is less, shall be formed at every female fitting opening except unions. The inside sleeve diameter shall be matched to the outside diameter of the conduit.
6. The PVC coating on the outside of conduit couplings shall have a series of longitudinal ribs 40 mils in thickness to protect the coating from tool damage during installation.
7. Form 8 Condulets® shall be supplied with plastic encapsulated stainless steel cover screws.
8. A urethane coating shall be uniformly and consistently applied to the interior of all conduit and fittings. This internal coating shall be a nominal 2 mil thickness. Conduit or fittings having areas with thin or no coating shall be unacceptable.
9. The PVC exterior and urethane interior coatings applied to the conduit shall afford sufficient flexibility to permit field bending without cracking or flaking at temperatures above 30deg.F (-1deg.C).

10. All male threads on conduit, elbows and nipples shall be protected by application of a urethane coating.
11. All female threads on fittings or conduit couplings shall be protected by application of a urethane coating.
12. Independent certified test results shall be available to confirm coating adhesion per ETL PVC-001 standards under the following conditions:

    a. Conduit immersed in boiling water with a minimum mean time to adhesion failure of 200 hours. ASTM D870)
    b. Conduit and condulet exposure to 150deg F (65deg C) and 95% relative humidity with a minimum mean time to failure of 30 days. (ASTM D11513.
    c. The interior coating bond shall be confirmed using the Standard Method of Adhesion by Tape Test (ASTM D3359).
    d. No trace of the internal coating shall be visible on a white cloth following six wipes over the coating which has been wetted with acetone (ASTM D1308).
    e. The exterior coating bond shall be confirmed using the methods described in Section 3.8, NEMA RN1.
    f. After these tests the physical properties of the exterior coating shall exceed the minimum requirements specified in Table 3.1, NEMA RN1.

13. Water tight flex connectors used in areas where PVC coated metal conduit is utilized shall be PVC coated also.
14. Shall be as manufactured by Perma-Cote, Plastibond, Korkap, Ocal or Okote.

B. Rigid Galvanized Steel and I.M.C.:

1. Shall be galvanized outside and inside by hot dipping.
2. Shall be as manufactured by Republic, Wheatland, Triangle, Pittsburg Standard, Youngstown, Allied or equal.

C. E.M.T.:

1. Shall be Electro-Galvanized.
2. Shall be as manufactured by Republic, Wheatland, Triangle, Pittsburg Standard, Youngstown, Allied or equal.

D. Rigid Aluminum:

1. Shall be manufactured of 6063 Alloy, T-1 temper.
2. Shall be as manufactured by Republic, Wheatland, Triangle, Pittsburg Standard, Youngstown, Allied or equal.

E. Schedule 40 and 80 PVC:

1. Shall be composed of polyvinyl chloride and shall be U.L. rated type 40 or 80 for use with 90 degree rated conductors. Conduit shall conform to NEMA Standards and applicable sections of N.E.C.
2. The conduit manufacturer shall have had a minimum of 5 years experience in the manufacture of the products. Non-metallic raceways shall be as manufactured by Carlon, Triangle, Can-Tex, Allied or equal.

F. HDPE Innerduct

1. Shall be composed high density polyethylene and shall be orange in color, unless noted otherwise.
2. Shall be corrugated unless noted otherwise.
3. Shall be manufactured by Carlon, Ipex or equal.

G. Flexible Metallic Conduit:

1. Shall be continuous spiral wound and interlocked galvanized material, code approved for grounding.

H. Liquidtight Flexible Metallic Conduit:

1. Shall be galvanized steel-core sealtite, code approved for grounding.
2. Shall have an outer liquidtight, nonmetallic, sunlight-resistant jacket over an inner flexible metal core.
3. Shall be as manufactured by Electric-Flex, Anaconda or equal.

2.2 FITTINGS, COUPLINGS & CONNECTORS

A. Rigid Galvanized Steel and I.M.C. couplings and connectors shall be standard threaded type, galvanized outside and inside by hot dipping. Threadless and clamp type are not acceptable. Couplings/connectors shall be as manufactured by Raco, Efcor, or Appleton or equal.

B. All fittings, conduit bodies, couplings and connectors (**including, but not limited to, condulettes, conduit couplings, connectors, hubs, nipples, unions, expansion fittings, explosion proof seal-offs, threaded hole closures, and seal-tight connectors, etc.**) used in areas where PVC-Coated Rigid conduit is used shall also be PVC-coated.

C. All fittings, conduit bodies, couplings and connectors (**including, but not limited to, condulettes, conduit couplings, connectors, hubs, nipples, unions, expansion fittings, explosion proof seal-offs, threaded hole closures, and seal-tight connectors, etc.**) installed in other wet, exterior or process areas where PVC-coated conduit systems are not required, shall be aluminum or stainless steel type. Standard steel fittings will not be acceptable.

D. All rain tight connectors shall be threaded Myers or approved equal, rated for outdoor application.

E. E.M.T. couplings and connectors shall be set screw, or steel compression type. All couplings and connectors shall be 720B, 730, 750B, or 760 series of Efcor or equal series of Raco. Pressure indented type connectors or cast metal will not be approved for any location. E.M.T. couplings and connectors shall be as manufactured by O-Z/Gedney, T&B, Efcor, Raco, Midwest or equal. E.M.T. fittings, couplings and connectors located within concrete (where allowed) shall be compression type and shall be adequately sealed with tape to ensure a concrete-tight seal.

F. Rigid Aluminum couplings and connectors shall be standard threaded type, of the same alloy as the associated conduit. Threadless and clamp type are not acceptable. Fittings shall be as

manufactured by Thomas & Betts, Crouse-Hinds, Appleton, Pyle-National or equal.

G. All PVC couplings, adapters, end bells, reducers, etc., shall be of same material as conduit.

H. Liquidtight Flexible Metallic Conduit connectors shall be liquidtight with insulating throat or end bushing, designed for application with Liquidtight Flexible Metallic Conduit. Fittings shall be as manufactured by Efcor, Raco, Midwest or equal.

I. All LB unilets sizes 1 ¼" or larger shall have rollers.

J. Miscellaneous conduit fittings shall be as manufactured by Appleton, Crouse-Hinds, Pyle-National, Russell & Stoll or equal.

2.3 BUSHINGS

A. All non-grounding rigid bushings 1-1/4" and larger shall be the insulating type (O-Z/Gedney type "BB" or equal by T&B, Midwest Electric or Penn Union).

B. All non-grounding rigid bushings 1" and smaller shall be threaded malleable iron with integral noncombustible insulator rated for 150°C. Non-grounding rigid conduit bushings shall be O-Z/Gedney type "B" or equal by T&B, Midwest Electric or Penn Union.

C. All grounding rigid bushings shall be threaded malleable iron with integral noncombustible insulator rated for 150°C. All grounding rigid conduit bushings shall be O-Z/Gedney type "BLG" or equal by T&B, Midwest Electric or Penn Union.

2.4 HARDWARE, CONDUIT CLAMPS AND SUPPORTS

A. All hardware such as expansion shields, machine screws, toggle bolts, "U" or "J" bolts, machine bolts, conduit clamps and supports shall be of corrosion resistant materials (stainless steel, aluminum, galvanized or plated steel, or other approved materials).

B. Hardware in contact with aluminum handrails, plates or structural members and all hardware in exterior, wet or corrosive areas shall be type 316 stainless steel or aluminum (with bitumastic paint coating to isolate aluminum from contact with concrete where necessary) unless specifically noted otherwise.

C. Supports in exterior, process, wet or corrosive locations shall be type 316 stainless steel or aluminum (with bitumastic paint coating to isolate aluminum from contact with concrete where necessary) unless specifically noted otherwise.

D. Supports in extremely corrosive environments (such as chlorine or fluoride storage rooms) shall be PVC-Coated steel unless specifically noted otherwise.

E. Hardware and conduit clamps shall be as manufactured by Efcor, Steel City, G.A., Tinnerman or equal.

2.5 WATERTIGHT ENTRANCE SEAL DEVICES

A. For new construction, seal devices shall consist of oversized sleeve and malleable iron body with sealing rings, pressure rings, sealing grommets and pressure clamps as required (O-Z/Gedney type FSK/WSK or equal).

B. For cored-hole applications, seal devices shall consist of assembled dual pressure disks with neoprene sealing rings and membrane clamps as required (O-Z/Gedney type CSM or equal).

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Minimum Diameter: 3/4-inch.

B. Raceway Type: Raceway types shall be as specified below, unless indicated otherwise on drawings:

1. Exterior, Exposed: Rigid Aluminum unless otherwise noted.
2. Exterior, Used for Instrumentation Circuits: See Below.
3. Other Exterior (Concrete-Encased or Direct Earth Buried): Schedule 40 PVC. PVC conduit shall convert to metallic conduit prior to exiting concrete-encasement or direct earth burial. See “transition” items below for additional requirements. Conduits shall be left exposed until after Engineer’s observation.
4. Interior, Exposed:
    a. Hazardous Locations: Rigid Aluminum .
    b. Wet Locations (including, but not limited to, Pump Rooms, Areas with exposed piping, Dewatering Rooms, Wet Wells, Underground Vaults, and other similar locations): Rigid Aluminum .
    c. Dry Locations: Rigid Aluminum.
    d. Extremely Corrosive Locations (Chlorine Storage Rooms, Fluoride Storage Rooms and other similar areas): Schedule 80 PVC.
5. Interior, Concealed:
    a. Embedded inside Poured Concrete Walls, Ceilings or Floors, with a minimum of 2” of concrete between finished surface and outer wall of conduit on all sides, where no anchor bolts, screws or other similar items will be installed: Schedule 40 PVC. PVC conduit shall convert to metallic conduit (exact type as specified elsewhere within this section) prior to exiting poured concrete-encasement of wall, ceiling, floor or ductbank. See “transition” items below for additional requirements.
    b. Other Raceways Embedded inside Poured Concrete Walls, Ceilings or Floors (not meeting requirements above): PVC-Coated Rigid Steel
    c. Other Raceways: E.M.T.
6. Raceways used for Instrumentation Circuits:

a. Typical Dry or Wet Locations: Rigid Aluminum .
b. Underground or Locations Embedded inside Poured Concrete: PVC-Coated Rigid Steel.
c. Extremely Corrosive Locations (Chlorine Storage Rooms, Fluoride Storage Rooms and other similar areas): PVC-Coated Rigid Steel.

7. Terminations at motors, transformers and other equipment which has moving or vibrating parts:

   a. Exterior or Wet Locations (including, but not limited to, Pump Rooms, Wet Wells, Underground Vaults, and other similar locations): Liquidtight Flexible Metallic Conduit (shall generally not exceed 24 inches in length) with watertight fittings.
   b. Dry, Interior Locations: Flexible Metallic Conduit (shall generally not exceed 24 inches in length).

8. Terminations at instruments:

   a. Liquidtight Flexible Metallic Conduit (shall generally not exceed 12 inches in length) with watertight fittings.

9. Terminations at fixtures mounted in grid-type ceilings:

   a. Flexible Metallic Conduit or MC cabling (shall generally not exceed 72 inches in length and shall run from junction box to fixture, not from fixture to fixture).

10. Transition from underground or concrete-encased to exposed:

    a. Convert PVC to PVC-Coated Rigid Steel utilizing PVC-Coated Rigid Steel 90 degree bends (and vertical conduits as required by application) prior to exiting concrete/grade (except at outdoor pull boxes and under freestanding electrical equipment, where terminations shall be by PVC end bells installed flush with top of slab). Exposed portions of these coated conduits shall extend a minimum of 6" above floor level, and shall be installed at uniform heights.

3.2 RACEWAY INSTALLATION

A. General:

1. Follow methods which are appropriate and approved for the location and conditions involved. Where not otherwise shown, specified, or approved in a particular case, run all wiring concealed.
2. Where conduit crosses a structural expansion joint an approved conduit expansion fitting shall be installed.
3. Where any run of rigid aluminum conduit (including bends) exceeds 50' in length, an approved conduit expansion fitting shall be installed (beginning at center of run) at intervals not to exceed 50' on center.
4. A non-conductive polypropylene pull string, properly tied/secured at either end, shall be installed in all empty conduits.

5. Metal conduit field-cuts shall be cut square with a hacksaw and the ends reamed after threading.
6. PVC conduit field-cuts shall be made with hacksaw, and ends shall be deburred.
7. All PVC joints shall be made as follows:

    a. Clean the outside of the conduit to depth of the socket, and the inside of socket with an approved cleaner.
    b. Apply solvent cement as recommended by the conduit manufacturer to the interior of the socket and exterior of conduit, making sure to coat all surfaces to be joined.
    c. Insert conduit into the socket and rotate 1/4 to 1/2 turn and allow to dry.

8. All metallic conduit installed below grade or within concrete shall be coated with two (2) spiral-wrapped layers of 3M Scotchrap 50 PVC tape or two coats of asphaltum paint prior to installation.
9. Install ground wire sized per N.E.C. Table 250.122 in all conduits.
10. Use of running threads is absolutely prohibited. Conduit shall be jointed with approved threaded conduit couplings. Threadless and clamp type not acceptable.
11. Conduits shall be sized in accordance with latest National Electrical Code except when size shown on drawings.
12. Exposed, field-cut threads on all metal conduits shall be painted with zinc primer (for Galvanized Rigid or I.M.C.) or urethane paint (for PVC-Coated Rigid Steel) as recommended by conduit manufacturer .
13. Installation of PVC coated conduit systems shall be performed in strict accordance with the manufacturer's installation instructions. Damage to PVC coated conduit coating shall be touched up with patching compound as directed by manufacturer. To assure correct installation, the installer shall be certified by the manufacturer to install coated conduit.

B. Routing/Locating:

1. Exposed conduit runs shall be run level and plumb and shall, on interior of buildings, be run parallel and/or at right angles to building walls and/or partitions.
2. Conduit with an external diameter larger than 1/3 the thickness of a concrete slab shall not be placed in the slab. Conduits in slab shall not be spaced closer than 3 diameters on center.
3. Conduit run in ceiling spaces shall be run as high as possible, all at same level, and shall be supported from building structure. Do not support conduit from any other installation.
4. Conduit run within exterior CMU, concrete or other similar walls shall be run within the CMU cells / concrete structure / etc. Conduits shall not be run on the outside surface of CMU cells / concrete structure / etc. underneath exterior veneers / etc., which could cause a thermal break in the wall insulation or a future water intrusion problem.
5. Install conduit runs to avoid proximity to steam or hot water pipes. In no place shall a conduit be run within 6" of such pipes except where crossing is unavoidable, then conduit shall be kept at least 3" from the covering of the pipe crossed.
6. Before installing raceways for motors, HVAC equipment and other fixed equipment, check location of all equipment connections/terminal boxes with equipment supplier and locate and arrange raceways appropriately.
7. No conduit for instrumentation shall be run closer than 12 inches to parallel power conduits.

8. A minimum of 12" of clearance (or more as required by associated utility companies) shall be provided between the finished lines of exterior, underground conduit runs and exterior, underground utilities (gas, water, sewer, etc.).
9. Where any portion of raceway is installed in a wet environment (such as below grade) and located at a higher elevation than the raceway termination point in a dry environment, install watertight compound inside raceway at termination around cabling to prevent transfer of water through conduit system. Watertight compound shall be rated for the potential water head pressure, based on the assumption that ground water level would be at grade level.

C. Bends:

1. Do not make bends (in any raceway, including flexible conduits) that exceed allowable conductor bending radius of cable to be installed or that significantly restrict conductor flexibility.
2. All bends within concrete-encased ductbanks installed in exterior locations shall be long radius bends (24" minimum bending radius – varies with conduit diameter).
3. All bends in raceways containing multi-conductor power cables (such as shielded VFD cables) shall be long radius bends (24" minimum bending radius – varies with conduit diameter).
4. Where numerous exposed bends or grouped together, all bends shall be parallel, with same center and shall be similar in appearance
5. All PVC elbows, bends, etc., shall be either factory bends or made with an approved heat bender.

D. Support:

1. Anchor conduit securely in place by means of approved conduit clamps, hangers, supports and fastenings. Arrangement and methods of fastening all conduits shall be subject to Engineer's direction and approval. All conduits shall be rigidly supported (wire supports may not be used in any location). Use only approved clamps on exposed conduit.
2. Rigid Aluminum Conduits shall be supported at intervals not to exceed 5' on center.
3. Conduit in riser shafts shall be supported at each floor level by approved clamp hangers.
4. Right angle beam clamps and U bolts shall be specially formed and sized to snugly fit the outside diameters of conduits.
5. Where installed in seismic zones, suspended raceways shall be braced in two (2) directions as required to prevent swaying and excessive movement.
6. Raceways installed on top of flat roofing shall be supported a minimum of 3 ½" above roof with rubber block supports (Cooper B-Line Dura-Blok or equal). Installation shall be in strict accordance with support manufacturer's instructions and recommendations.

E. Terminations:

1. All conduit connections to sheet metal cabinets or enclosures located in exterior or wet locations shall terminate by use of rain tight (Meyers) hubs.
2. In wet, exterior or process areas, conduits shall NOT enter tops of enclosures. All conduits shall enter enclosures from bottom, left or right sides of the enclosure (utilizing rain-tight Meyers hubs as indicated above).
3. Where rigid or I.M.C. conduits enter sheet metal boxes, they shall be secured by approved lock nuts and bushings.

4. Where metal conduits enter outdoor pull boxes, manholes, under freestanding electrical equipment or other locations where direct metal-to-metal contact does not exist between enclosure and conduit, grounding bushings shall be installed. Each grounding bushing shall be connected to the enclosure ground and all other grounding bushings with properly sized grounding conductors.
5. Where E.M.T. enters sheet metal boxes they shall be secured in place with approved insulating fittings.
6. Where PVC enters outdoor pull boxes, manholes or under freestanding electrical equipment, PVC end bells shall be installed.
7. Contractor shall be responsible for coordinating required conduit sizes with equipment hubs/conduit entry provisions (such as at motor tap boxes) prior to installation of conduit systems. Contractor shall field adjust final conduit sizes at terminations where so required (only as allowed by code) from those indicated on plans to coordinate with equipment hubs/conduit entry provisions.
8. Where conduit terminates in free air such that associated cabling/circuitry becomes exposed (such as at cable trays, etc.), conduit shall generally terminate in a horizontal orientation (to prevent dust/debris/etc. from entering conduit system). Where vertical conduit termination is necessary, the termination shall be provided with cord-grip conduit terminations to seal the conduit system.
9. Conduit ends shall be carefully plugged during construction.
10. Permanent, removable caps or plugs shall be installed on each end of all empty raceways with fittings listed to prevent water and other foreign matter from entering the conduit system.

F. Penetrations:

1. All fire/smoke barrier penetrations shall be made in accordance with a U.L. listed assembly. Refer to drawings and other specifications for additional requirements.
2. All penetrations shall be at right angles unless shown otherwise.
3. Structural members (including footings and beams) shall not be notched or penetrated for the installation of electrical raceways unless noted otherwise without specific approval of the structural engineer.
4. Dry-packed non-shrink grout or watertight seal devices shall be used to seal openings around conduits at all penetrations through concrete walls, ceilings or aboveground floors.
5. All raceways entering structures, or where water is otherwise capable of entering equipment/devices through the raceway system, shall be sealed (at the first box or outlet) with foam duct sealant to prevent the entrance of gases or liquids from one area to another or into equipment/devices.

    a. Where the elevation of the raceway penetration (into the structure) is no more than 15’ below the other (higher) end of the same raceway, Polywater FST sealant (rated to hold back up to 22’ of continuous water head pressure), or pre-approved equal, shall be used.
    b. Where the elevation of the raceway penetration (into the structure) is between 15’ and 75’ below the other (higher) end of the same raceway, Polywater PHRD Custom Mechanical Seals (rated to hold back up to 36psi or 83’ of continuous water head pressure), or pre-approved equal, shall be used.
    c. Where the elevation of the raceway penetration (into the structure) is more than 75’ below the other (higher) end of the same raceway, the contractor shall propose a

custom solution designed to hold back or to drain the possible water within the associated raceway. Submittals shall be provided to the engineer for review/approval, including a summary of the anticipated elevations/PSIs, details of the proposed installation, cut-sheets of devices/materials, etc.

6. Additionally, where necessary to ensure that water does not enter equipment/devices through the raceway system (where raceways extend to equipment/devices from wet areas), junction boxes with drain assemblies in bottom shall be located at low point of raceway system near equipment/devices (to drain water out of raceway system before it enters equipment/devices). Contractors shall provide drains in raceway systems where so necessary to prevent water entry into equipment/devices. In special applications (such as to instruments, etc.,), where cabling rated for exposed application is provided, contractor may propose short air gaps (approximately 6" or less) between the end of the conduit system and the equipment/device cable entry (to be made with cable gland connectors) to prevent water in conduit system from entering equipment/devices in lieu of drained junction boxes.
7. All raceways passing through concrete roofs or membrane-waterproofed walls or floors shall be provided with watertight seals as follows:

    a. Where ducts are concrete encased on one side: Install watertight entrance seal device on the accessible side of roof/wall/floor as directed by equipment manufacturer.
    b. Where ducts are accessible on both sides: Install watertight entrance seal device on each side of roof/wall/floor as directed by equipment manufacturer.

8. All raceways passing through walls of rooms containing/storing noxious chemicals (chlorine, ammonia, etc.) or through hazardous locations shall be sealed with conduit seals (Crouse-Hinds type EYS or equal).
9. All raceways terminating into electrical enclosures/devices/panels/etc. located in hazardous locations shall be sealed with conduit seals (Crouse-Hinds type EYS, EZS or equal) within 18" of the termination.

G. Exterior Electrical Ductbanks:

1. Where exterior electrical concrete-encased ductbanks are indicated on drawings, conduit runs between buildings or structures shall be grouped in concrete-encased ductbanks as follows:

    a. A minimum of 3" of concrete shall encase each side of all ductbanks.
    b. A minimum of 1 ½" of separation shall be provided between each conduit within ductbanks. PVC spacers shall be installed at the necessary intervals prior to placement of concrete to maintain the required spacing and to prevent bending or displacement of the conduits.
    c. Top of concrete shall be a minimum of 30" below grade. A continuous magnetic marking tape shall be buried directly above each ductbank, 12" below grade.
    d. Exact routing of ductbanks shall be field verified and shall be modified as necessary to avoid obstruction or conflicts.
    e. Underground electrical raceways shall be installed to meet the minimum cover requirements listed in NEC Table 300.5. Refer to drawings for more stringent requirements.

END OF SECTION 26 05 33

SECTION 26 05 34 - OUTLET BOXES, JUNCTION BOXES, WIREWAYS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Outlet and Junction Boxes

B. Pull Boxes

C. Wireways

PART 2 - PRODUCTS

2.1 OUTLET BOXES & JUNCTION BOXES (THROUGH 4-11/16")

A. Sheet Metal: Shall be standard type with knockouts made of hot dipped galvanized steel as manufactured by Steel City, Raco, Appleton, Bowers or equal.

B. Cast: Shall be type FS, FD, JB, GS, or SEH as required for application as manufactured by O-Z/Gedney, Appleton, or equal.

C. Nonmetallic: Shall be type Polycarbonate/ABS construction as required for application with non-metallic quick-release latches as manufactured by Hoffman, O-Z/Gedney, Appleton, or equal.

2.2 JUNCTION AND PULL BOXES (LARGER THAN 4-11/16")

A. Oil-Tight JIC: Shall be Hoffman Type CH box or approved equal.

B. Galvanized Cast Iron or Cast Aluminum: Shall be O-Z/Gedney or approved equal.

C. Stainless Steel: Shall be as manufactured by O-Z/Gedney, Hoffman or approved equal. Boxes shall have continuous hinges, seamless foam-in-place gaskets and screw-down clamps.

D. Nonmetallic: Shall be type Polycarbonate/ABS construction as required for application with non-metallic quick-release latches as manufactured by Hoffman, O-Z/Gedney, Appleton, or equal. Boxes shall have hinged covers and screw-down clamps.

E. Wireways: Shall be standard manufacturer's item as manufactured by Hoffman, Square "D", Burns, B & C or equal. Wireways shall have hinged covers and screw-down clamps.

F. Pre-cast Polymer Concrete Below-Grade Hand Holes & Pull Boxes:

1. Enclosures, boxes and cover are required to be UL Listed and conform to all test provisions of ANSI/SCTE 77 “Specifications For Underground Enclosure Integrity” for Tier 15 applications (15,000lb design load and 22,500lb test load) unless noted otherwise.
2. All covers shall have a minimum coefficient of friction of 0.05 in accordance with ASTM C1028 and the corresponding Tier level shall be embossed on the top surface.
3. Cover shall be bolt-down include factory-labeling to read “Electric”, “Communications” or other as directed.
4. Hardware shall be stainless steel.
5. Shall be Quazite PG/LG Style or approved equal.

G. Above-Grade Padmounted Low Profile Pull Boxes:

1. Construction:

   a. 12Ga. stainless steel base with 12Ga aluminum top with brushed finish, and structural bracing as required.
   b. Continuous base frame with open bottom and eight (8) ½” x 1” slots for securing box to concrete pad below and a center support member.
   c. Two (2) full-size swing-open lids with full-length, stainless steel continuous hinges, lifting handles, key-locking provisions and provisions for latching lids in open position (with stainless steel chain or approved equal).
   d. Guides on lid and base frame as required to ensure proper closing of box and to provide increased security.
   e. Aluminum or stainless steel barrier between power & instrumentation areas within box if box is used for both power and instrumentation wiring.
   f. Other stainless steel hardware as required.

2. Minimum Dimensions:

   a. Power: 40 inches square x 18 inches high.
   b. Instrumentation: 24 inches square x 18 inches high.

3. Manufacturer:

   a. Electrical Enclosure Mfg. (Pell City, AL).
   b. Ebox (Pelham, AL).
   c. Approved Equal.

PART 3 - EXECUTION

3.1 APPLICATION

A. General

1. All boxes and wireways shall be of sufficient size to provide free space for all enclosed conductors per NEC requirements. Fill calculations shall be performed by contractor per NEC requirements.

B. Outlet Boxes & Junction Boxes (through 4-11/16")

a. Sheet metal boxes shall be used on concealed work in ceiling or walls.

2. Cast boxes shall be used wherever Rigid or I.M.C. conduits are installed. Cast boxes shall be Cast Aluminum wherever installed in same locations as Rigid Aluminum conduit
3. All boxes installed in extremely corrosive areas (such as chlorine and fluoride storage rooms) where non-metallic raceways are used shall be non-metallic.
4. Except when located in exposed concrete block, switch and receptacle boxes shall be 4" square for single gang installation. Appropriate gang boxes shall be used for mounting ganged switches.
5. When installed in exposed concrete block, switch and receptacle boxes shall be square type designed for exposed block installation.
6. Ceiling outlet boxes shall be 4" octagon 1-1/2" deep or larger required due to number of wires.
7. Boxes installed in hazardous locations shall be explosion-proof rated for the associated application, constructed of copper-free cast aluminum.

C. Junction & Pull Boxes (larger than 4-11/16")

1. For all below grade exterior use and elsewhere as shown:

a. In areas subject to future vehicular traffic: shall be galvanized cast iron (rated AASHTO H-20 Loading unless noted otherwise).
b. In areas not subject to vehicular traffic: shall be galvanized cast iron or pre-cast polymer concrete (rated for Tier 15 Loading unless noted otherwise).

2. All boxes installed exposed in exterior or wet areas shall be stainless steel (NEMA 4X).
3. All boxes installed exposed in corrosive areas shall be stainless steel (NEMA 4X).
4. All boxes installed in extremely corrosive areas (such as chlorine and fluoride storage rooms) where non-metallic raceways are used shall be non-metallic.
5. Padmounted Pull Boxes shall be installed as shown on Plans or as required by project conditions. Transclosure-style Padmounted boxes shall be installed wherever required by the quantities and sizes of conductors. Contractor shall submit all Padmounted Pull Box types prior to ordering for engineer's review and comment.
6. Boxes installed in hazardous locations shall be explosion-proof rated for the associated application, constructed of copper-free cast aluminum.
7. All others shall be oil tight JIC box not less than 16 gauge.

3.2 INSTALLATION

A. General

1. All boxes and wireways shall be securely anchored.
2. All boxes shall be properly sealed and protected during construction and shall be cleaned of all foreign matter before conductors are installed.
3. All boxes and wireways shall be readily accessible. Contractor shall be responsible for furnishing and installing access panels per architect's specifications. Locations shall be

as directed by the architect as required to make boxes, wireways, electrical connections, etc. accessible where above gypsum board ceilings or in other similar locations.

4. All metallic boxes and wireways shall be properly grounded.
5. Refer to Specification Section 26 05 53 for identification requirements.

B. Outlet Boxes & Junction Boxes (through 4-11/16")

1. Boxes shall be provided with approved 3/8" fixture studs were required.
2. Recessed boxes for wiring devices, surface fixtures, or connections, shall be set so that the edge of cover comes flush with finished surface.
3. There shall be no more knockouts opened in any sheet metal box than actually used.
4. Any unused opening in cast boxes shall be plugged.
5. Back to back boxes to be staggered at least 3 inches.
6. Under no circumstances shall through-the-wall boxes be used.

C. Junction & Pull Boxes (larger than 4-11/16")

1. Pull boxes shall be installed as indicated on plans and/or as required due to number of bends, distance or pulling conditions.
2. Boxes to be imbedded in concrete shall be properly leveled and anchored in place before the concrete is poured.
3. All pull boxes and/or junction boxes installed exterior below grade, shall have their tops a minimum of 1-1/2 inches above surrounding grade and sloped so that water will not stand on lid. A positive drain shall be installed, to prevent water accumulation inside.
4. Above grade pull boxes shall be installed on concrete anchor bases as shown on Plans.

D. Wireways and/or wall-mounted equipment

1. Mount each wireway to channels of the same metal type as the wireway.
2. Conductors serving a wireway shall be extended without reduction in size, for the entire length of the wireway. Tap-offs to switches and other items served by the wireway shall be made with ILSCO type GTA with GTC cap.

END OF SECTION 26 05 34

SECTION 26 05 53 - ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Wire and cable identification.

B. Pullbox & Junction Box Identification

C. Electrical distribution & utilization equipment identification.

D. Instrument and control device identification.

E. Raceway identification.

PART 2 - PRODUCTS

2.1 WIRE AND CABLE IDENTIFICATION

A. Intermediate Locations:

1. Wires and cable labels shall be white, thermal transfer, halogen-free, flame-retardant marker plates (sized to accommodate three lines of text) permanently affixed to the associated cable with UV-resistant plastic wire ties. Labels shall be Panduit #M200X/300X series or equal.

B. Circuit/Cable Termination Locations:

1. Wires and cable labels shall be non-ferrous identifying tags or pressure sensitive labels unless noted otherwise.

2.2 ELECTRICAL DISTRIBUTION & UTILIZATION EQUIPMENT IDENTIFICATION

A. Labels on electrical distribution & utilization equipment shall be black-on-white engraved Bakelite nameplates permanently affixed to the equipment with rivets or silicone adhesive unless noted otherwise.

2.3 INSTRUMENT AND CONTROL DEVICE IDENTIFICATION

A. Instruments and control device labels shall be black-on-white engraved Bakelite nameplates permanently affixed to the equipment or the adjacent, visible mounting surface with silicone adhesive or stainless steel wire ties.

2.4 RACEWAY IDENTIFICATION

A. Raceway labels shall be white thermal transfer marker plates permanently affixed to the associated raceway with stainless steel wire ties, with two wire ties (one on either end of marker plate to provide a flush installation) where possible. Labels shall be Panduit #M300X series or equal.

PART 3 - EXECUTION

3.1 GENERAL

A. Any proposed deviation in identification methods and materials from those described herein shall be submitted to Engineer for review and comment prior to installation.

B. Contractor shall provide all labeling or identification required by applicable local, state and national codes. These specifications do not intend to itemize all code-required labeling or identification requirements.

C. All labels/identification shall be positioned such as to be readable from the normal perspective without adjusting wiring/cables/labels. For example, labels/identification of wires/cables within cable trays shall be positioned to point towards the viewer (typically downward for overhead cable trays, or upward for cable trays within trenches).

D. All labels/identification (except for handwritten labels on concealed pullbox/junction box covers as noted below) shall be typewritten/printed/engraved in a neat, workmanlike, permanent, legible, consistent and meaningful manner. Labels shall not be handwritten unless specific approval is granted by engineer.

3.2 WIRE AND CABLE IDENTIFICATION

A. General:

1. Where cabling is exposed (such as within cable trays), provide two wire ties per cable (one on either end of marker plate to provide a flush installation). Where cabling is concealed (such as within pullboxes/wireways), one wire tie per cable will be acceptable.

B. Intermediate Locations:

1. Thermal transfer labels shall be securely fastened to all wiring and cabling in the following locations:

    a. Wireways
    b. Pullboxes/Junction boxes larger than 4-11/16”
    c. Pullboxes/Junction boxes through 4-11/16” where wires and cables are not easily identifiable via the color coding and box labeling
    d. Vaults & Manholes

e. Approximately every 50 feet within cable trays (especially at locations where cables exit or diverge). Labels within cable trays shall be grouped (rather than being pre-labeled on cables and pulled into cable trays).
f. Other similar intermediate locations.

2. Labels shall be stamped or printed with the following data so that the feeder or cable can be readily identified and traced:

a. From where the circuit originates (including panel designation and circuit number):

1) Ex: “FROM: PP-A CIR. 3 (IN MAIN ELEC ROOM)”

b. To where the circuit extends (using the common name of the equipment):

1) Ex: “TO: RTU-6 (ON ROOF)”

c. The purpose of the circuit:

1) Ex: “POWER”

d. The set number (If parallel power feeds are used).

1) Ex: “SET NO. 3 OF 4”

C. Circuit/Cable Termination Locations:

1. Where multiple termination points exist within a circuit origination point (panelboard, switchboard, MCC, starter, etc.) or other similar circuit endpoint (control panel, etc.), labels shall be securely fastened to all ungrounded and neutral conductors to clearly identify the terminal and/or circuit number associated with each conductor. For example, within lighting panels, each phase and neutral conductor shall be labeled near the terminals at a clearly visible location with the associated circuit number(s), so that if all conductors were unterminated, the labels would clearly indicate which conductor was associated with each circuit.

D. Refer to Specification Section 26 05 19 for all color-coding requirements of wires and cables.

3.3 PULLBOX & JUNCTION BOX IDENTIFICATION

A. Concealed pullboxes/junction boxes:

1. Front surface of all pullbox/junction box covers in concealed areas (such as above lay-in ceilings) or within mechanical/electrical rooms (and other similar areas where appearance of boxes is not an issue) shall be neatly marked with the ID of circuits/cables contained with permanent black marker on cover of box (Ex: “RP-1A Cir. 1, 2 & 3”). Additionally, front surface of box shall be painted red where box contains fire alarm system cabling.

B. Exposed pullboxes/junction boxes:

1. Interior surface of all pullbox/junction box covers in exposed areas shall be labeled "Power", "Telecommunications", "Fire Alarm" or with other similar general text neatly with permanent black marker to indicate function of box. Circuit/cable labeling within box (see above) shall identify specific cables contained. Additionally, interior surface of cover shall be painted red where box contains fire alarm system cabling.

C. Where pullboxes/junction boxes are named on contract documents (Ex:"PULLBOX #3"), an engraved nameplate shall be installed on the front surface of the box to identify the name.

3.4 ELECTRICAL DISTRIBUTION & UTILIZATION EQUIPMENT IDENTIFICATION

A. General:

1. All new and existing equipment modified by this project shall include arc-flash warning labels in accordance with NEC article 110.16.

B. All Panels, Motor Control Centers, Switchboards, Switchgear, Transformers, Etc.:

1. Engraved nameplates identifying name of equipment, nominal voltage and phase of the equipment and where the equipment is fed from shall be installed on front surface of all panels, motor control centers, switchboards, switchgear, transformers, etc.:

   a. Ex: First Line: "NAME: RP-A", Second Line: "120/208V-3Ø-4W", Third Line: "FED FROM: PP-A CIR. 4 (IN MAIN ELEC ROOM)"

2. Refer to Panelboard Specification Sections for additional labeling requirements (circuit directory cards, permanent circuit labels, permanent circuit numbers, etc.) required inside panelboards.

C. Safety/Disconnect Switches and Utilization Equipment (HVAC Equipment, Pumps, Powered Valves, Control Panels, Starters, Etc.)::

1. Engraved nameplates identifying equipment being fed and where the equipment is fed from shall be installed on front surface of all disconnect switches (including both visible blade type switches and toggle-type switches) and on utilization equipment (where not clearly identified by immediately adjacent local disconnect switch):

   a. Ex: First Line: "RTU-6", Second Line: "FED FROM: PP-A CIR. 5"

2. Where safety/disconnect switches are installed on the load side of variable frequency drives, the safety/disconnect switch shall be furnished with an additional engraved nameplate to read: "WARNING: TURN OFF VFD PRIOR TO OPENING THIS SWITCH".
3. Safety/Disconnect switches feeding equipment that is fed from multiple sources (such as motors with integral overtemperature contacts that are monitored via a control system) and Utilization Equipment fed from multiple sources shall be furnished with an additional BLACK-ON-YELLOW engraved nameplate to read: "WARNING: ASSOCIATED EQUIPMENT FED FROM MULTIPLE SOURCES – DISCONNECT ALL SOURCES PRIOR TO OPENING COVER".

3.5 INSTRUMENT AND CONTROL DEVICE IDENTIFICATION

A. New Instruments and control devices (whether furnished by contractor or not) shall be labeled with black-on-white engraved nameplates permanently affixed to the equipment or to the adjacent, readily-visible mounting surface with silicone adhesive or stainless steel wire ties.

1. Instruments and process control devices (float switches, etc.) shall be labeled with instrument name and, where available, instrument ID number.
2. Pushbutton stations shall be labeled with equipment being controlled. Labels shall be installed on front surface (or adjacent mounting surface) of all pushbutton stations.
3. Thermostats and other similar HVAC control devices installed in process areas shall be labeled with equipment being controlled. Labels shall be installed on front surface (or adjacent mounting surface) of all thermostats and other similar HVAC control devices.

3.6 RACEWAY IDENTIFICATION

A. Each exposed raceway shall be labeled at the point where it becomes concealed, such as where it enters a concrete floor slab, a concrete wall, the ground, etc.

B. Each raceway entering in-grade or on-grade pullboxes/junction boxes, where the conduits are only visible inside the box, shall be labeled within the box at the point where the raceway becomes concealed.

C. Raceway nameplates shall identify:

1. The location of the other end of the raceway (“TO MCC-1” or similar). If the other end of the raceway is at an intermediate, named pullbox (“INSTRUMENTATION PULLBOX #4” or similar), that pullbox name shall be labeled rather than the endpoint of the circuitry.

3.7 OTHER IDENTIFICATION

A. Factory-engraved coverplates identifying functions of light switches and other similar devices shall be installed where so required by plans/specifications.

END OF SECTION 26 05 53

SECTION 26 24 19 - MOTOR CONTROL CENTERS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section includes requirements for motor control centers (MCC's) and all required control devices as shown on the drawing and specified to be part of the MCC equipment. The MCC shall be 277/480 V, 3-Phase, 4-Wire, 60 Hz unless otherwise indicated.

B. Modifications to existing motor control centers shall use products/devcies/hardware/installation/etc. matching existing to the greatest extent possible unless specifically noted otherwise.

1.2 SUBMITTALS

A. Submittals shall be furnished in accordance with Specification Section 26 05 00.

B. Submittals shall show separate views of the elevation, profile and conduit openings. The elevation shall show the section identification and the unit identification. The drawings shall give dimensions of size and location of the following:

1. Vertical section height, width and depth
2. Mounting channels
3. Conduit openings top and bottom
4. Wireway openings in sides
5. Horizontal buss
6. Ground buss

C. The submittals shall contain a summary of the design specification containing but not limited to the following:

1. NEMA type enclosure and class of wiring
2. Rated buss voltage
3. Current ratings for horizontal buss, vertical busses and ground buss
4. Buss material and plating

D. Buss bracing and sheet circuit rating

E. The submittals shall contain a listing of all modifications, options and special equipment.

F. The submittals shall contain a listing of each unit containing but not limited to the following:

1. Unit Location
2. Nameplate
3. Major contents of unit (fuse starter, CB switch, M.C.P., etc.) complete with NEMA size and heater rating or current rating.

4. Size of load served (H.P. KVA, KW, etc.).

G. Provide the following for each starter/controls unit:

1. A job-specific, custom wiring diagram

a. The wiring diagram shall clearly show all control components (whether the components are mounted internal or external to the MCC enclosure).
b. All wires and terminal blocks shall be clearly labeled.
c. Diagram shall be in accordance with NEMA/ICS standards.

2. Size, type and rating of all system components.
3. Unit frontal elevation and dimension drawings.
4. Internal component layout diagrams.
5. Manufacturer's product data sheets for all components.

H. Submittals shall be complete and electrical contractor shall review and approve all accessories required for control wiring prior to submittal

1.3 REGULATORY REQUIREMENTS

A. The MCC shall conform to Underwriters Laboratory (UL) 845, current revision, CSA, EEMAC, NEMA ICS-2, the latest version of the National Electrical Code, and the Canadian Electrical Code. The MCC shall be manufactured in an ISO 9001 certified facility.

1.4 WARRANTY

A. An eighteen-month warranty shall be provided on materials and workmanship from date of owner acceptance/substantial completion after completion of startup.

PART 2 - PRODUCT

2.1 MANUFACTURERS

A. Additions to existing MCCs shall be the same as the original manufacturer.

2.2 MATERIALS

A. Steel material shall comply with UL 845 and CSA requirements.

B. Each MCC shall consist of one or more vertical sections of heavy gauge steel bolted together to form a rigid, free-standing assembly. A removable 7 gauge structural steel lifting angle shall be mounted full width of the MCC shipping block at the top. 10 gauge bottom channel sills shall be mounted underneath front and rear of the vertical sections extending the full width of the shipping block. Vertical sections made of welded side-frame assembly formed from a

minimum of 12 gauge steel. Internal reinforcement structural parts shall be of 12 and 14 gauge steel to provide a strong, rigid assembly. The entire assembly shall be constructed and packaged to withstand normal stresses included in transit and during installation.

C. Each entire MCC assembly (including all sub-components) shall be rated to withstand (and provide proper breaker functionality within) the fault current ratings listed on the plans. When a power distribution system electrical study (including short circuit stud, etc.) is a part of the project, contractor shall further verify that all proposed equipment is properly rated (per the results of the study) prior to submitting shop drawings. The fault current ratings listed shall be assumed to be at the input terminals of the associated MCC.

2.3 MCC FINISH

A. All steel parts shall be provided with UL and CSA listed acrylic/alkyd baked enamel paint finish, except plated parts used for ground connections. All painted parts shall undergo a multi-stage treatment process, followed by the finishing paint coat.

B. Pre-treatment shall include:

1. Hot alkaline cleaner to remove grease and oil.
2. Iron phosphate treatment to improve adhesion and corrosion resistance.

C. The paint shall be applied using an electro-deposition process to ensure a uniform paint coat with high adhesion.

D. The standard paint finish shall be tested to UL 50 per ASTM B117 (5% ASTM Salt Spray) with no greater than 0.125 in (3 mm) loss of paint from a scribed line.

E. Paint color shall be #49 medium light gray per ANSI standard Z55.1-967 (60-70 gloss) on all surfaces unless specified otherwise. Paint color of additions to existing MCCs shall match that of the existing MCC. Control station plates and escutcheon plates shall be a contrasting gray.

2.4 STRUCTURES

A. Structures shall be totally enclosed, dead-front, free-standing assemblies. Structures shall be capable of being bolted together to form a single assembly.

B. The overall height of the MCC shall not exceed 90 in (2286 mm) (not including base channel or lifting angle). Lifting angles, of 3 in (76 mm) in height, shall be removable. The total width of one section shall be 20 in (508 mm); (widths of 25 in (630 mm), 30 in (760 mm), and 35 in (890 mm) can be used for larger devices). The total depth of each section shall be 20 in (508 mm) unless shown otherwise.

C. Structures shall be NEMA/EEMAC type 1 unless shown/specified otherwise.

D. Each 20 in wide standard section shall have all the necessary hardware and bussing for modular plug-in units to be added and moved around. All unused space shall be covered by hinged blank doors and equipped to accept future units. Vertical bus openings shall be covered by

manual bus shutters.

E. Each section shall include a top plate (single piece or two-piece). NEMA/EEMAC type 12 shall also include a bottom plate. Top and bottom plates shall be removable for ease in cutting conduit entry openings.

F. All MCC components, terminations, wiring, etc. shall be fully accessible from the front of the MCC unless noted otherwise.

2.5 WIREWAYS

A. Structures shall contain a minimum 12 in (305 mm) high horizontal wireway at the top of each section and a minimum 6 in (152 mm) high horizontal wireway at the bottom of each section. These wireways shall run the full length of MCC to allow room for power and control cable to connect between units in different sections.

B. A full-depth vertical wireway shall be provided in each MCC section that accepts modular plug-in units. The vertical wireway shall connect with both the top and bottom horizontal wireway. The vertical wireway shall be 4 in (102 mm) wide minimum with a separate hinged door. There should be a minimum of 80 in^2 (516 cm^2) of cabling space available for 20-inch-deep sections. Access to the wireways shall not require opening control unit doors. Structures that house a single, full section control unit are not required to have vertical wireways. Those control units shall open directly into the MCC horizontal wireways.

C. All wireway doors shall be hinged and shall be held shut by captive hardware.

2.6 BARRIERS

A. All power bussing and splice connections shall be isolated from the unit compartments and the wireways. The horizontal bus shall be mounted onto a glass filled polyester support assembly that braces the bus against the forces generated during a short circuit. The horizontal bus shall be isolated from the top horizontal wireway by a two-piece rigid non-conductive barrier. The barrier design shall allow qualified personnel to slide the barriers both left and right, to allow access to the bus and connections for maintenance without having to remove the barrier. Barrier sliding shall occur via an upper and lower track system.

B. The vertical bus shall be housed in a molded glass-filled polyester support that provides bus insulation and braces the bus against the forces generated during a short circuit. These supports shall have openings every 3 in (75 mm) for unit stab-on connections. Each opening shall be provided with a manual shutter to close off the stab opening. These shutters shall be attached to the structure so that when they are removed (to allow a stab connection) they are retained in the structure and are readily accessible for use should a plug-in unit be removed from the MCC.

C. Barriers shall be provided in the vertical structure and unit designs to prevent the contact of any energized bus or terminal by a fishtape inserted through the conduit or wireway areas.

2.7 BUSSING

A. All bussing and connectors shall be tin-plated copper.

B. The main horizontal bus shall be rated as indicated on plans and shall extend the full length of the MCC. Bus ratings shall be based on 65° C maximum temperature rise in a 40° C ambient. Provisions shall be provided for splicing additional sections onto either end of the MCC.

C. The horizontal bus splice bars shall be pre-assembled into a captive bus stack. This bus stack is installed into the end of the MCC power bus to allow the installation of additional sections. The main bus splice shall utilize four bolts, two on each side of the bus split, for each phase. Additional bolts shall not be required when splicing higher amperage bus. The splice bolts shall secure to self clenching nuts installed in the bus assembly. It shall be possible to maintain any bus connection with a single tool.

D. A neutral bus and/or neutral lugs (with amperage rating equal to that of the main horizontal bus) shall be provided for all 4-wire motor control centers.

E. Each section that accepts plug-in units shall be provided with a vertical bus for distributing power from the main bus to the individual plug-in starter units. This bus shall be of copper and plating as the main bus, and shall be rated 300 A or 600 A continuous based on UL standards (and the associated loads connected to the bus). The vertical bus shall be connected directly to the horizontal bus stack without the use of risers or other intervening connectors. It shall be possible to maintain the vertical to horizontal bus connection with a single tool. "Nut and bolt" bus connections to the power bus shall not be permitted. When a back-to-back unit arrangement is utilized, separate vertical bus shall be provided for both the front and rear units.

F. A tin-plated copper ground bus shall be provided that runs the entire length of the MCC. The ground bus shall be rated for 25% (minimum) of the main horizontal bus amperage. Compression lugs shall be provided in the MCC for a ground cable, sized to accommodate the grounding connections shown on plans. The ground bus shall be provided with six (6) holes for each vertical section to accept customer-supplied ground lugs for any loads requiring a ground conductor.

G. Each vertical section shall have a tin-plated copper vertical ground bus that is connected to the horizontal ground bus. This vertical ground bus shall be installed so that the plug-in units engage the ground bus prior to engagement of the power stabs and shall disengage only after the power stabs are disconnected upon removal of the plug-in unit.

H. The system shall be rated for an available short circuit capacity as indicated on plans. When a power distribution system electrical study (including short circuit stud, etc.) is a part of the project, contractor shall further verify that all proposed equipment is properly rated (per the results of the study) prior to submitting shop drawings. Interrupting ratings shall be full ratings. Series ratings will not be allowed unless specifically shown otherwise on drawings.

2.8 TYPICAL UNIT CONSTRUCTION

A. Units with circuit breaker disconnects through 400 A frame, and fusible switch disconnects through 400 A, shall connect to the vertical bus through a spring reinforced stab-on connector. Units with larger disconnects shall be connected directly to the main horizontal bus with appropriately sized cable or riser bus.

B. All circuit breakers rated (or able to be adjusted to) 1200A or higher shall be electronic trip and shall be provided with arc energy-reducing maintenance switching (with local status indicator) to reduce arc flash energy per NEC 240.87 requirements.

C. All circuit breakers shall have adjustable magnetic trip settings. Provide a field adjustable breaker to allow for one breaker for each NEMA size starter. The adjustment range shall include current range to encompass the entire range of each size starter. There shall also be adjustments to select either standard or high inrush magnetic settings, from 6 times to 13 times motor full load current. If a standard, non adjustable, magnetic only trip breaker is furnished for a combination starter unit, the manufacturer shall include in the bid cost to furnish and install replacement breakers at jobsite if equipment changes dictate.

D. All conducting parts on the line side of the unit disconnect shall be shrouded by a suitable insulating material to prevent accidental contact with those parts.

E. Unit mounting shelves shall include hanger brackets to support the unit weight during installation and removal. All plug-on units shall use a twin-handle camming lever located at the top of the bucket to rack in and out the plug-on unit. The cam lever shall work in conjunction with the hanger brackets to ensure positive stab alignment.

F. A lever handle operator shall be provided on each disconnect. With the unit stabs engaged onto the vertical phase bus and the unit door closed, the handle mechanism shall allow complete ON/OFF control of the unit. All circuit breaker operators shall include a separate TRIPPED position to clearly indicate a circuit breaker trip condition. It shall be possible to reset a tripped circuit breaker without opening the control unit door. Clear indication of disconnect status shall be provided, by adhering to the following operator handle positions:

1. Handle "On" position shall be up or to the left and within 45 degrees of being parallel to the face of the equipment.
2. Handle "Off" position shall be down or to the right and within 45 degrees of being parallel to the face of the equipment.
3. The minimum separation between the "On" and "Off" positions shall be 90 degrees.
4. On Circuit Breaker disconnects, the handle "Tripped" position shall be perpendicular to the face of the equipment +/- 30 degrees. Minimum separation between "On" and "Tripped" shall be 30 degrees. Minimum separation between "Tripped" and "Off" shall be 45 degrees.

G. A mechanical interlock shall prevent the operator from opening the unit door when the disconnect is in the ON position. Another mechanical interlock shall prevent the operator from placing the disconnect in the ON position while the unit door is open. It shall be possible for authorized personnel to defeat these interlocks.

H. A non-defeatable interlock shall be provided to prevent installing or removing a plug-in unit unless the disconnect is in the OFF position.

I. The plug-in unit shall have a grounded stab-on connector which engages the vertical ground bus prior to, and releases after, the power bus stab-on connectors.

J. Provisions shall be provided for locking all disconnects in the OFF position with up to three padlocks.

K. Handle mechanisms shall be located on the left side to encourage operators to stand to the left of the unit being switched.

L. Unit construction shall combine with the vertical wireway isolation barrier to provide a fully compartmentalized design.

M. All unit doors shall be hinged and shall be held shut by captive hardware.

N. Interiors of all units shall be painted white.

2.9 COMPONENTS FOR TYPICAL UNITS

A. Main Lugs

1. Main and sub-feed lugs shall be provided with AL/CU compression lugs suitable for the quantities and sizes of conductors required.

B. Circuit Breakers

1. Where the highest continuous current trip setting for which the actual overcurrent device installed in a circuit breaker is rated (or can be adjusted to is 1200A or higher, breakers shall be electronic trip and shall be provided with arc energy-reducing maintenance switching (with local status indicator) to reduce arc flash energy per NEC 240.87 requirements.
2. Circuit breakers shall be quick-make and quick-break, whether actuated automatically or manually. Circuit breakers shall have inverse time tripping characteristics with automatic release which shall trip free of the handle. Circuit breaker handles shall be three distinct positions—"OFF", "ON", and "TRIPPED". When a circuit breaker opens on overload or short circuit, the operating handle shall automatically assume the "TRIPPED" position.

C. Combination Starters

1. All combination starters shall utilize a unit. Magnetic starters shall be furnished in all combination starter units unless specifically shown otherwise. All starters shall utilize full NEMA/EEMAC rated contactors (size 1 minimum).
2. Starters shall be provided with a three-pole, external (door mounted) manual reset, solid state overload relay . Solid state overload relay shall have switch-selectable trip class and shall provide protection from:

    a. Overload.
    b. Phase Unbalance.
    c. Phase Loss.
    d. Ground Fault (Class II detection).

3. Unless specifically shown otherwise, each combination starter shall be furnished with a control circuit transformer including two primary protection fuses and one secondary fuse (in the non-ground secondary conductor). The transformer shall be sized to accommodate the contactor(s) and all connected control circuit loads (including motor space heaters and other similar loads where specified). The transformer rating shall be fully visible from

the front when the unit door is opened. Unless otherwise indicated, control voltage shall be 120V AC. Control power shall be provided by individual unit control power transformers.

4. When a unit control circuit transformer is not provided, the disconnect shall include an electrical interlock for disconnection of externally powered control circuits.
5. Auxiliary control circuit interlocks shall be provided where indicated. Auxiliary interlocks shall be field convertible to normally open or normally closed operation.
6. NEMA/EEMAC Size 1-4 starters shall be mounted directly adjacent to the wireway so that power wiring (motor leads) shall connect directly to the starter terminals without the use of interposing terminals. Larger starters shall be arranged so that power wiring may exit through the bottom of the starter cubical without entering the vertical wireway.
7. Each starter shall be equipped with a minimum of the following control devices:

    a. Door-mounted reset button.
    b. Two (2) field-reversible (N.O./N.C.) auxiliary contacts
    c. For reversing and two-speed starters: Four (4) field-reversible (N.O./N.C.) auxiliary contacts
    d. Additional control devices as indicated on plans.

D. Terminal Blocks

1. Wiring within all units shall be type B, with unit-mounted control terminal blocks for each field wire.
2. Terminal blocks shall be the pull-apart type 600 volt and rated at 25 amps. All current carrying parts shall be tin plated. Terminals shall be accessible from inside the unit when the unit door is opened. Terminal blocks shall be DIN rail mounted with the stationary portion of the block secured to the unit bottom plate. The stationary portion shall be used for factory connections, and shall remain attached to the unit when removed. The terminals used for field connections shall face forward so they can be wired without removing the unit or any of its components.

E. Nameplates

1. Each unit shall be properly labeled with an engraved phenolic nameplate with a white background and black letters.
2. Each pilot device shall be properly labeled with a legend plate or an engraved phenolic nameplate.

F. Wiring

1. All wiring shall be identified on each end with hot stamped or shrink tube type permanent wire markers to correspond with numbering shown on wiring diagrams.

G. Wiring Diagram

1. A job-specific, custom wiring diagram for each unit shall be provided to the contractor prior to installation for making the appropriate electrical connections. The wiring diagram shall clearly show all control components connected to each unit (whether the components are mounted internal or external to the soft start enclosure). All wires and

terminal blocks shall be clearly labeled. A laminated copy of the final wiring diagram for each unit shall be installed inside the door of the associated unit.

H. Control Components:

1. All pushbuttons, pilot lights, selector switches and other control devices shall be separate, standard size (full 30mm) and shape, heavy duty oil-tight units.
2. All pilot lights to be cluster LED type & push to test.
3. Relays:

a. Control relays shall have the following characteristics, unless noted otherwise:

1) General purpose, plug-in type.
2) Minimum mechanical life of 10 million operations.
3) Coil voltage as indicated or required by application.
4) Single-break contacts rated 12 amperes, resistive at 240 volts.
5) Contacts as shown on wiring diagrams plus a minimum of one (1) spare N.O. contact and one (1) spare N.C. contact. At a minimum, each individual relay shall have 3PDT contacts. Where required, multiple control relays shall be provided (to provide the required quantities of contacts) for each "relay" function shown on plans/diagrams.
6) Furnished with RC transient suppressor to suppress coil-generated transients to 200% of peak voltage.
7) LED on/off indicator light and manual operator.
8) Industry standard wiring and pin terminal arrangements.
9) Equal to Square D 8501KP series with matching plug-in socket.

b. Interposing/isolation relays used to isolate input/output field wiring from PLC inputs/outputs shall be terminal-block style. Terminal-block style relays shall have the following characteristics, unless noted otherwise:

1) Minimum mechanical life of 10 million operations.
2) Single-break contacts rated 6 amperes, resistive at 120 volts.
3) One (1) N.O. contact per relay.
4) Furnished with integral transient protection.
5) LED on/off indicator light.
6) DIN-rail mounted.
7) Equal to Square D type Zelio RSL.

c. Timer relays shall be electronic, adjustable plug-in devices meeting the following characteristics, unless noted otherwise:

1) General purpose, plug-in type.
2) Minimum mechanical life of 10 million operations.
3) Single-break contacts rated 10 amperes, resistive at 240 volts.
4) Contacts as shown on wiring diagrams plus a minimum of one (1) spare N.O. contact and one (1) spare N.C. contact. At a minimum, each relay shall have DPDT contacts (2 N.O. & 2N.C.). Where required, multiple timer or control relays shall be provided (to provide the required

quantities of contacts) for each "relay" function shown on plans/diagrams.

5) Rotary-thumbwheel adjustments for time value, timing range and function.
6) Time value adjustments from .05 seconds to 999 hours
7) Selectable Timing Functions, including the following:

    a) On Delay
    b) Interval
    c) Off Delay
    d) One Shot
    e) Repeat Cycle-Off
    f) Repeat Cycle-On
    g) On/Off Delay
    h) One Shot Falling Edge
    i) Watchdog
    j) Trigger On Delay

8) Accuracy shall be $\pm$ 2% and repeatability shall be $\pm$ 0.1%.
9) Furnished with integral transient protection.
10) LED indicator light(s) for "timing" and "on/off status"
11) Held in place with hold-down spring
12) Equal to Square D type JCK with matching plug-in socket.

2.10 QUALITY CONTROL

A. The entire MCC shall go through a quality inspection before shipment. This inspection shall include:

1. Physical Inspection of:

    a. Structure.
    b. Electrical conductors, including:

        1) bussing.
        2) general wiring.
        3) units.

2. Electrical Tests

    a. General electrical tests include:

        1) power circuit phasing.
        2) control circuit wiring.
        3) instrument transformers.
        4) meters.
        5) ground fault system.
        6) device electrical operation.

b. AC dielectric tests shall be performed on the power circuit.

3. Markings/Labels, include:

a. instructional type.
b. Underwriters Laboratory (UL)/Canadian Standards Association (CSA).
c. inspector's stamps.

4. The manufacturer shall use integral quality control checks throughout the manufacturing process to ensure that the MCC meets operating specifications.

B. The motor control center design shall be in accordance with the latest applicable standards of NEMA and Underwriters Laboratories.

2.11 SPECIAL REQUIREMENTS

A. Where the schedules and diagrams show deviations from these Specifications, the schedules and diagrams shall take precedence, but only for the particular feature.

PART 3 - EXECUTION

3.1 PACKING/SHIPPING

A. The MCC shall be separated into shipping blocks no more than three vertical sections each. Shipping blocks shall be shipped on their sides to permit easier handling at the jobsite. Each shipping block shall include a removable lifting angle, which shall allow an easy means of attaching an overhead crane or other suitable lifting equipment.

3.2 STORAGE

A. If the MCC cannot be placed into service reasonably soon after its receipt, store it in a clean, dry and ventilated building free from temperature extremes. Acceptable storage temperatures shall be determined by the manufacturer. Anti-condensation space heaters shall be provided during equipment storage as directed by the manufacturer.

3.3 LOCATION

A. Motor control centers shall not be placed in hazardous locations. The area chosen shall be well ventilated and totally free from humidity, dust and dirt. Where the minimum temperature of the area is less than 0° C (32° F), space heaters shall be provided within the motor control center. Where the minimum temperature of the area is greater than 40° C (104° F) ventilation fans and/or air conditioning units shall be provided within the motor control center as required to provide adequate cooling for each unit. For indoor locations, protection shall be provided to prevent moisture entering the enclosure .

B. Motor control centers shall be located in an area with a minimum of 4 ft (1219 mm) of free space in front of front-of-board construction. This free space shall give adequate room to remove and install units. A minimum of 0.5 in (13 mm) space should be provided between the back of front-of-board MCCs and a wall, 6 in (152 mm) required for damp locations.

C. The MCCs shall be assembled in the factory on a smooth level surface so that all sections are properly aligned. A similar smooth and level surface shall be provided for installation. An uneven foundation will cause misalignment of shipping blocks, units, and doors. The surface under a MCC shall be of a non-combustible material unless bottom plates are installed in each vertical section.

3.4 INSTALLATION

A. Motor control centers shall be installed on six inch thick concrete pads unless specifically shown otherwise. Pad shall extend a minimum of four inches to all sides and shall have beveled edges.

B. Orientation of motor control centers shall be as shown on the Engineer's drawings. Space requirements are critical on this project and therefore special care shall be taken to ensure that equipment will fit in the designated space. To ensure proper coordination, the MCC manufacturer shall submit with shop drawings a 1/2"=1'-0" scale floor plan of each electrical room showing all columns, doors, walls and proposed equipment. Manufacturer shall not bid equipment that will not fit in available space.

C. All motor control center dimensions and clearances shall be carefully checked and coordinated with the proper trades to ensure proper mounting space and support prior to roughing in equipment.

D. Motor control centers shall be grounded in two places as specified on drawings.

E. Verify all accessories as shown on drawings. Perform all necessary additions and modifications to make the motor control center to the Engineer's drawings.

F. A job-specific, custom wiring diagram for each unit shall be provided to the contractor prior to installation for making the appropriate electrical connections. The wiring diagram shall clearly show all control components connected to each unit (whether the components are mounted internal or external to the soft start enclosure). All wires and terminal blocks shall be clearly labeled. A laminated copy of the final wiring diagram for each unit shall be installed inside the door of the associated unit.

G. Operations and Maintenance Manuals and a listing of the nearest and most convenient source of replacement parts and service shall be provided to the owner for all MCC components, control wiring, etc.

H. Operations and Maintenance Manuals shall include hardcopy printouts of all device settings and programming.

I. For safety, reliability, and continuity of warranty, any modifications, alterations, etc. required to conform to the requirements of this specification shall be performed by the MCC manufacturer

only. Distributor modifications, third party packaging, etc. of a manufacturer's standard product are specifically disallowed.

J. Services shall include a minimum of eight (8) hours of field/classroom training for owner's personnel on routine operation and maintenance of the specified units.

3.5 SPARE PARTS

A. The following spare parts shall be provided at no extra cost to the Owner:

1. One of each type and size of control fuse.

END OF SECTION 26 24 19

SECTION 26 27 26 - WIRING DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Wiring Devices

B. Plates

C. Finishes

PART 2 - PRODUCTS

2.1 WIRING DEVICES AND PLATES

A. Switches shall be AC type, extra-heavy duty industrial grade (unless otherwise shown) of ratings shown on drawings. Switches shall be as manufactured by Hubbell, P & S, Sierra, Bryant, GE, Arrow Hart or equal.

B. Receptacles shall have blade configuration and shall be heavy duty industrial grade (unless otherwise shown) of current and voltage rating as shown on drawings. Receptacles shall be as manufactured by Hubbell, P & S, Sierra, Bryant, GE, Arrow Hart or equal.

C. All GFCI-type receptacles shall continuously self-test and shall trip/deny power if the receptacle does not provide proper GFCI protection or if the line/load terminations are miswired and shall provide visual indication of power status, trip conditions, ground fault conditions and end-of-life status.

D. Each wiring device shall have a plate (see “Finishes” section below for specific requirements).

2.2 FINISHES

A. All wiring devices (switches, receptacles, etc.) shall be colored to match the coverplates described below. For instance, all items covered by stainless steel, aluminum or malleable iron plates shall be gray in color.

B. Coverplates for recessed, wall-mounted electrical items (switches, receptacles, telephone outlets, etc.) shall be stainless steel unless shown otherwise.

C. Coverplates, trim rings, etc. for recessed, floor-mounted electrical items (floor outlets, underfloor duct junctions, etc.) shall match finish of building hardware (302/304 stainless steel, brass, etc.) in area installed.

D. Coverplates for exposed electrical items (switches, receptacles, telephone outlets, etc.) shall be

of same material as exposed boxes (see Outlet Box Specification for required material type) and shall have beveled edges.

E. Coverplates for receptacles in wet locations shall be metallic, in-use type, rated for wet locations per NEC requirements unless noted otherwise.

F. See “Electrical Identification” specification section for coverplate labeling requirements.

PART 3 - EXECUTION

3.1 GENERAL MOUNTING

A. Symbols on drawings and mounting heights are approximate. The exact locations and mounting heights shall be determined on the job, and it shall be the Contractor's responsibility to coordinate with all trades to secure correct installation. For example, Contractor shall coordinate exact mounting heights over counters, in or above backsplashes, in block walls, and at other specific construction features.

B. Verify all door swings with Architectural. Locate boxes for light switches within four inches of door trim on swing side (not hinge side) of door.

C. Devices and associated plates shall not be used as support; outlet boxes shall be rigidly supported from structural members.

D. Mount all straight-blade receptacles vertically with ground pole up, unless specifically noted otherwise.

E. Unless otherwise shown or required by local handicap codes, outlet boxes shall be the following distances above the finished floor unless otherwise noted.

1. Receptacles and telephone outlets in offices and other finished areas: 1’-6” to the center of the box.
2. Receptacles and telephone outlets in equipment rooms and other unfinished areas: 4’-0” to the center of the box.
3. Receptacles over counters: As Noted
4. Switches, general: 4’-0” to the top of the box.
5. Push-button, etc., general: 4’-0” to the top of the box.
6. Other device types: verify with engineer prior to rough-in.

END OF SECTION 26 27 26

SECTION 26 28 16 - SAFETY SWITCHES AND FUSES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Safety Switches

B. Fuses

C. Branch Feeders

D. Feeders

PART 2 - PRODUCTS

2.1 SAFETY SWITCHES

A. Safety switches shall be quick-make, quick-break, NEMA heavy duty type HD, fused or nonfused as shown. Switch blades shall be fully visible in the off position.

B. Safety switches shall be furnished with transparent internal barrier kits to prevent accidental contact with live parts. Barriers shall provide finger-safe protection when the switch door is open and shall allow use of test probes and removal of fuses without removing barrier.

C. Fused switches shall have provisions for class R, rejection type fuses.

2.2 FUSES (600V)

A. Fuses for all branch switches shall be Bussman Mfg. Co., Dual Element, Class “R” Fusetron.

B. Fuses for main switch/switches shall be Bussman Mfg. Co. Hi-Cap.

2.3 MANUFACTURER

A. Safety switches shall be as manufactured by Square 'D' or Cutler Hammer.

B. Fuses shall be as manufactured by Bussman Mfg. Co. or equal.

PART 3 - EXECUTION

3.1 SAFETY SWITCHES

A. Safety switches shall be installed as shown on the plans and in accordance with N.E.C.

B. Locations shown for safety switches on plans are diagrammatical only. Exact locations shall be field coordinated by contractor as required to provide code-required clearances.

C. Switch enclosures shall be rated NEMA I indoors in dry locations and NEMA 4X stainless steel outdoors and in wet or process areas.

D. Adequate support shall be provided for mounting safety switches. Safety switches shall not be mounted to the associated equipment (unless the safety switch is furnished with the equipment).

3.2 FUSES

A. Fuses shall be sized as shown on drawings, unless a smaller size is required by the associated equipment supplier, in which case the contractor shall provide fuses sized as directed by the associated equipment supplier at no additional cost.

B. Provide not less than one spare set of fuses for each size used. Provide an additional spare set for each five sets of same size fuses used.

END OF SECTION 26 28 16

SECTION 26 29 00 - MANUFACTURED CONTROL PANELS

PART 1 - GENERAL

1.1 SCOPE

A. This section describes control stations, PLC panels, motor control panels, manufactured control panels, and other similar panels specified herein. Specifications herein are intended as an extension of requirements in other Divisions of these specifications where reference is made to Electrical Specifications.

1.2 DEFINITIONS

A. "Control Stations": Enclosures (with all required accessories) containing only door-mounted pushbuttons, indicator lights and/or selector switches (no electronic components or starter/controller equipment).

B. "Control Panels": Enclosures (with all required accessories) containing equipment/devices other than door-mounted pushbuttons, indicator lights and/or selector switches (such as electronic components, starter/controller equipment, etc.).

1.3 SUBMITTALS

A. Provide the following for each control panel:

1. A job-specific, custom wiring diagram

    a. The wiring diagram shall clearly show all components (whether the components are mounted internal or external to the control panel enclosure).
    b. All wires and terminal blocks shall be clearly labeled.
    c. Diagram shall be in accordance with NEMA/ICS standards.

2. Size, type and rating of all system components.
3. Unit frontal elevation and dimension drawings.
4. Internal component layout diagrams.
5. Manufacturer's product data sheets for all components.

B. A Bill of Materials shall be included with catalog information on all components.

C. Information shall be included on any proprietary logic component sufficient to demonstrate its ability to perform the required functions.

D. The following calculations shall be submitted:

1. Thermal calculations showing amount of panel cooling/ventilating/heating required for each control panel, per ambient requirements listed below and operating temperature

limitations of all equipment/devices within each control panel. See Part 2 below for requirements for forced air ventilation rather than air conditioning. Panel shall be oversized, interior equipment/devices shall be derated, and solar shielding shall be provided as required to allow the use of forced air ventilation as the cooling method. Air conditioning, ventilation, and/or heating equipment shall each have ratings/capacities at least 20% larger than required by calculations below unless noted otherwise:

a. Thermal calculations used for sizing cooling/ventilation systems for each control panel located in exterior or non-conditioned spaces shall assume:

1) Ambient exterior air temperature ranges of -5 degrees F to 105 degrees F.
2) Full solar contact where applicable (not applicable where enclosures are fully protected from solar contact using solar shields separated from panel enclosure with standoffs or similar).
3) No wind.
4) Heat loss from interior equipment (electronics, etc.) per equipment supplier's information.

b. Thermal calculations used for sizing heating systems for each control panel shall assume:

1) Ambient exterior air temperature ranges of -5 degrees F to 105 degrees F.
2) No heat loss by interior components of control panel.
3) No solar gain on exterior of control panel.
4) Doubling of heating wattage required to account for wind where control panels are located outdoors.
5) Minimum temperature difference (due to heating) of 10 degrees F to prevent condensation, regardless of equipment temperature limitations.

2. Load calculations showing the sizing of all power supplies provided (with spare capacity as specified). Power supplies shall each have ratings/capacities at least 20% larger than required by load calculations unless noted otherwise.
3. Load calculations showing the sizing and anticipated runtime of all Uninterruptible Power Supply systems provided (with spare capacity as specified).

PART 2 - PRODUCTS

2.1 GENERAL

A. Control panels shall be Underwriters' Laboratories labeled by the panel manufacturer. Control panel manufacturers not capable of applying the U.L. label to their products are unacceptable.

B. All human interface equipment/devices (indicator lights, selector switches, pushbuttons, time switches, displays, keypads, and other similar items used for control, adjustments or monitoring) shall be mounted on the non-energized side of enclosure door(s) in such a way as to be accessible without exposing the user to energized parts.

C. All

2.2 RATINGS

A. All Control Panels shall have short circuit current ratings at least equal to the lesser of the following, unless noted otherwise on plans:

1. The short circuit current rating of the electrical distribution equipment that feeds the Control Panel.
2. 150% of the available fault current at the Control Panel as determined by a Short Circuit Current study prepared by a licensed professional electrical engineer.

B. All equipment/devices installed within control panels shall be rated to operate in ambient temperatures of 50 degrees C (122 degrees F) or higher.

2.3 ENCLOSURES

A. All enclosures (with any required accessories or auxiliary items) shall fit within the space shown on the Plans. Any costs associated with furnishing equipment which exceeds the available space shall be borne by the Contractor.

B. Enclosures (with any required accessories or auxiliary items) shall be suitable for the environment where installed.

C. Enclosure materials shall be as follows unless noted otherwise:

1. Control Stations:

a. Where located in extremely corrosive areas (chlorine rooms, fluoride rooms, etc.): NEMA 4X of non-metallic construction (with non-metallic hardware) compatible with the associated chemical(s).
b. Where located in other wet, process or outdoor areas: NEMA 4X of type 304 stainless steel construction (with stainless steel hardware).
c. Where located in dry, non-process, indoor areas (such as electrical rooms): NEMA 1 of die cast zinc/aluminum construction.

2. Control Panels:

a. Where located in extremely corrosive areas (chlorine rooms, fluoride rooms, etc.): NEMA 4X of non-metallic construction (with non-metallic hardware) compatible with the associated chemical(s).
b. Where located in other wet, process or outdoor areas: NEMA 4X of type 304 stainless steel construction (with stainless steel hardware).
c. Where located in dry, non-process, indoor areas (such as electrical rooms): NEMA 1 or 12.

D. Control Panel Enclosure Construction:

1. Non-metallic control panel enclosure material, where specified, shall be reinforced polyester resin or equivalent, with a minimum thickness of 3/16 inch for all surfaces except those requiring reinforcement. Panels shall be precision molded to form a one piece unit with all corners rounded. Exterior surfaces shall be gel-coated to provide a corrosion-resistant maintenance-free satin finish which shall never need painting. Color pigments shall be molded into the resin. Color shall be grey.
2. Metallic control panel enclosures, where specified, shall be fabricated using a minimum of 14 gauge steel for wall or frame mounted enclosures and a minimum of 12 gauge for freestanding enclosures. Continuously weld all exterior seams and grind smooth. Reinforce sheet steel with steel angles where necessary support equipment and ensure rigidity and preclude resonant vibrations.
3. Use pan-type construction for doors.
4. Door widths shall not exceed 36-inches.
5. Mount doors with full length, heavy duty piano hinge with hinge pins.
6. Provide gasket completely around each door opening.
7. Mount and secure all internal components to removable back plate assembly.
8. For NEMA 1 or 12 enclosures, provide handle-operated key-lockable three point stainless steel latching system for each door.
9. For NEMA 4X enclosures, provide provisions for padlocking all doors and provide clamps on three (3) sides of each door.

E. Control panel enclosures (and associated backpanels and other similar accessories) shall be manufactured by Hoffman Engineering Co., or Saginaw Control & Engineering.

2.4 CONTROL PANEL ACCESSORIES:

A. Panel ventilation systems shall be provided if so required by the application to maintain temperatures within the acceptable ranges of the interior equipment. In no case (regardless of temperature ratings of internal equipment) shall maximum temperatures within control panels be allowed to exceed 50 degrees C (122 degrees F). Panel Air Conditioners or Heat Exchangers (to satisfy the specified thermal calculation requirements) are generally NOT acceptable unless specifically stated otherwise in these specifications, and shall not be provided for panels without specific written direction from the engineer PRIOR to submission of panel shop drawings. Panels shall be oversized, provided with standoffs/shields, and/or ventilated as required to meet the contract requirements. Thermostats shall be provided to control cooling without need of manual operation. Thermostat setpoints shall be as per recommendations of the equipment suppliers. See above for thermal calculation requirements. Cooling units shall be as manufactured by Hoffman Engineering Co., Rittal or approved equal and shall be thermostatically controlled.

B. Space heaters shall be provided for condensation and temperature control. Thermostats AND hygrostats (or combination hygrotherm controllers) shall be provided to control heating requirements (based on temperature and relative humidity within enclosure) without need of manual operation. Setpoints shall be as per recommendations of the equipment suppliers. See above for thermal calculation requirements. Space heaters and associated control devices shall be as manufactured by Hoffman Engineering Co., Rittal, Stego or approved equal.

C. NEMA 4X control panels shall be provided with vapor-phase corrosion inhibitor(s) (chemical combinations that vaporize and condense on all surfaces in the enclosed area, to protect metal

surfaces/devices within the enclosed area from corrosion). Corrosion inhibitor shall be Hoffman #AHCI series (sized as required by the enclosure volume to be protected) or equal.

D. For outdoor panels, stainless steel solar shields for front, top and each side of panel, supported to associated panel face with standoffs as required (to allow free air flow between solar shield and panel enclosure), shall be provided where required to limit solar loading on panel to allow use of a ventilated panel design rather than an air-conditioned panel design.

E. Provide a sun shield over all LCD displays in exterior-mounted panels. Sun shield shall be collapsible to fully protect LCD display from UV light when not in use, shall provide side and top shielding when in use, shall be constructed of stainless steel and shall be installed such as to maintain NEMA 4X ratings of enclosures.

F. Provide a clear polycarbonate gasketted hinged door or window to encompass all indicators, controllers, recorders, etc. mounted on NEMA 4 and 4X enclosures.

G. Provide interior mounting panels and shelves constructed of minimum 12 gauge steel with white enamel finish. Provide metal print pocket with white enamel finish on inside of door.

H. Provide interior LED light kit, mounted at top of interior of panel, and switched to turn "ON" when door is opened for the following control panels:

1. Control panels with outer dimensions greater than 20" wide or 30" high.
2. Control panels containing PLCs or other similar programmable devices.

I. Control panels containing VFDs or Reduced Voltage Soft Starters shall include a door mounted digital keypad for adjusting the starter parameters and viewing process values and viewing the motor and starter statuses without opening the enclosure deadfront door.

2.5 CONTROL COMPONENTS

A. General:

1. All pushbuttons, pilot lights, selector switches and other control devices shall be separate, standard size (full 30mm) and shape, heavy duty oil-tight units.

    a. Devices in extremely corrosive areas (chlorine rooms, fluoride rooms, etc.) shall be of non-metallic construction.
    b. Devices in other areas shall be of chrome-plated construction.

2. All components and devices so that connection can be easily made and so there is ample room for servicing each item.
3. Door-mounted indicators, recorders, totalizers and controllers shall be located between 48" and 72" above finished floor level.
4. Door-mounted indicator lights, selector switches and pushbuttons shall be located between 36" and 80" above finished floor level.
5. All devices and components shall be adequately supported to prevent movement. Mounting strips shall be used to mount relays, timers and other devices suitable for this type of mounting.

B. Pilot Lights:

1. All pilot lights to be cluster LED type & push to test.

C. Pushbuttons:

1. All STOP operators within control stations located at equipment shall be provided with lockout provisions and a minimum of two (2) sets of contact blocks.
2. Emergency shutoff pushbutton devices shall be as follows unless noted otherwise:

    a. 2 ¼" diameter, mushroom-style, maintained contact push buttons
    b. With a minimum of one (1) normally open dry contact and three normally closed dry contacts.
    c. Connections made such that pushing "in" the button will shutoff the associated equipment.
    d. Provided with a red engraved nameplate with ½" lettering to read "Emergency Shutoff".

D. Relays:

1. Control relays shall have the following characteristics, unless noted otherwise:

    a. General purpose, plug-in type.
    b. Minimum mechanical life of 10 million operations.
    c. Coil voltage as indicated or required by application.
    d. Single-break contacts rated 12 amperes, resistive at 240 volts.
    e. Contacts as shown on wiring diagrams plus a minimum of one (1) spare N.O. contact and one (1) spare N.C. contact. At a minimum, each individual relay shall have 3PDT contacts. Where required, multiple control relays shall be provided (to provide the required quantities of contacts) for each "relay" function shown on plans/diagrams.
    f. Furnished with RC transient suppressor to suppress coil-generated transients to 200% of peak voltage.
    g. LED on/off indicator light and manual operator.
    h. Industry standard wiring and pin terminal arrangements.
    i. Equal to Square D 8501KP series with matching plug-in socket.

2. Interposing/isolation relays used to isolate discrete output field wiring (and where required for voltage translation for other discrete signals) to/from PLC inputs/outputs shall be terminal-block style. Terminal-block style relays shall have the following characteristics, unless noted otherwise:

    a. Minimum mechanical life of 10 million operations.
    b. Single-break contacts rated 6 amperes, resistive at 120 volts.
    c. One (1) N.O. contact per relay.
    d. Furnished with integral transient protection.
    e. LED on/off indicator light.
    f. DIN-rail mounted.
    g. Equal to Square D type Zelio RSL.

3. Timer relays shall be electronic, adjustable plug-in devices meeting the following characteristics, unless noted otherwise:

    a. General purpose, plug-in type.
    b. Minimum mechanical life of 10 million operations.
    c. Single-break contacts rated 10 amperes, resistive at 240 volts.
    d. Contacts as shown on wiring diagrams plus a minimum of one (1) spare N.O. contact and one (1) spare N.C. contact. At a minimum, each relay shall have DPDT contacts (2 N.O. & 2N.C.). Where required, multiple timer or control relays shall be provided (to provide the required quantities of contacts) for each "relay" function shown on plans/diagrams.
    e. Rotary-thumbwheel adjustments for time value, timing range and function.
    f. Time value adjustments from .05 seconds to 999 hours
    g. Selectable Timing Functions, including the following:

        1) On Delay
        2) Interval
        3) Off Delay
        4) One Shot
        5) Repeat Cycle-Off
        6) Repeat Cycle-On
        7) On/Off Delay
        8) One Shot Falling Edge
        9) Watchdog
        10) Trigger On Delay

    h. Accuracy shall be $\pm$ 2% and repeatability shall be $\pm$ 0.1%.
    i. Furnished with integral transient protection.
    j. LED indicator light(s) for "timing" and "on/off status"
    k. Held in place with hold-down spring
    l. Equal to Square D type JCK with matching plug-in socket.

2.6 DC POWER SUPPLIES

A. DC Power supplies shall be provided where specified elsewhere, or as required by design of system. Power supplies shall be industrial type, AC-to-DC switching, output voltage as required, 120vac input, size as required for the initial application plus 50% spare capacity.

B. Redundant power supplies with diode isolation shall be provided so that the loss of one power supply does not affect system operation. The back-up supply systems shall be designed so that either the primary or the back-up supply can be removed, repaired, and returned to service without disrupting the system operation.

C. Power supply output shall be protected by secondary overcurrent protection device(s).

D. The power distribution from multiloop supplies shall be selectively fused so that a fault in one instrument loop will be isolated from the other loops being fed from the same supply.

E. Each power supply shall meet the following requirements.

1. Regulation, line: 0.4% for input from 105 to 132vac.
2. Regulation, load: 0.8%
3. Ripple/Noise: 15mV RMS / 200 mV peak to peak
4. Operating temperature range: 0 deg C - 60 deg C
5. Overvoltage protection
6. Overload Protection
7. Output shall remain within regulation limits for a least 16ms after loss of AC power at full load.
8. Output status indicator.
9. UL listing

F. Power supplies shall be manufactured by Puls, Sola, Phoenix Contact or equal.

2.7 DISCONNECTS

A. A main disconnect switch or circuit breaker shall be supplied integral to all control panels. The main disconnect or circuit breaker shall be accessible/operable without exposing the operator to energized sections of the control panel(s), and shall be lockable in the open/off position.

B. Individual circuit breakers shall be provided integral to the manufactured control panel for each separate power circuit originating within the control panel.

C. Where the highest continuous current trip setting for which the actual overcurrent device installed in a circuit breaker is rated (or can be adjusted to is 1200A or higher, breakers shall be electronic trip and shall be provided with arc energy-reducing maintenance switching (with local status indicator) to reduce arc flash energy per NEC 240.87 requirements.

D. Manufacturers:

1. Square 'D' or Cutler Hammer.

2.8 COMBINATION STARTERS

A. All combination starters shall utilize a unit disconnect. Magnetic starters shall be furnished in all combination starter units unless specifically shown otherwise. All starters shall utilize full NEMA/EEMAC rated contactors (size 1 minimum).

B. Starters shall be provided with a three-pole, external (door mounted) manual reset, solid state overload relay. Solid state overload relay shall have switch-selectable trip class and shall provide protection from:

1. Overload.
2. Phase Unbalance.
3. Phase Loss.
4. Ground Fault (Class II detection).

C. Unless specifically shown otherwise, each combination starter or each group of starters shall be furnished with a control circuit transformer including two primary protection fuses and one

secondary fuse (in the non-ground secondary conductor). The transformer shall be sized to accommodate the contactor(s) and all connected control circuit loads (including motor space heaters and other similar loads where specified). The transformer rating shall be fully visible from the front when the unit door is opened. Unless otherwise indicated, control voltage shall be 120V AC. Control power shall be provided by individual unit control power transformers.

D. When a unit control circuit transformer is not provided, the disconnect shall include an electrical interlock for disconnection of externally powered control circuits.

E. Auxiliary control circuit interlocks shall be provided where indicated. Auxiliary interlocks shall be field convertible to normally open or normally closed operation.

F. NEMA/EEMAC Size 1-4 starters shall be mounted directly adjacent to the wireway so that power wiring (motor leads) shall connect directly to the starter terminals without the use of interposing terminals. Larger starters shall be arranged so that power wiring may exit through the bottom of the starter cubical without entering the vertical wireway.

G. Each starter shall be equipped with a minimum of the following control devices:

1. Door-mounted reset button.
2. Two (2) field-reversible (N.O./N.C.) auxiliary contacts
3. For reversing and two-speed starters: Four (4) field-reversible (N.O./N.C.) auxiliary contacts
4. Additional control devices as indicated on plans.

H. Control Wiring Terminal Blocks

1. Terminal blocks shall generally be:

a. Feed-thru, screw-in type
b. DIN rail mounted
c. Furnished with the stationary portion of the block secured to the unit bottom plate
d. Furnished with unit-mounted control terminal blocks for each field wire.
e. Rated for the voltage and current of the proposed application per UL/NEC standards.
f. Sized (by supplier) for the associated wire gauges/types/quantities.
g. Phoenix Contact UT-4 series, Weidmuller WDU-4 series (or equivalent) unless required otherwise by application.

I. Nameplates

1. Each unit shall be properly labeled with an engraved phenolic nameplate with a white background and black letters.
2. Each pilot device shall be properly labeled with a legend plate or an engraved phenolic nameplate.

J. Manufacturers:

1. Square 'D' or Cutler Hammer.

2.9 WIRING

A. Refer to Section 26 05 19 for all wiring types/applications.

B. All wiring shall be identified on each end with hot stamped, shrink tube type, or self-laminating vinyl permanent wire markers to correspond with numbering shown on wiring diagrams.

C. All connections shall be made on terminals with no splices.

D. All wiring runs shall be along horizontal or vertical routes to present a neat appearance. Angled runs will not be acceptable. Group or bundle parallel runs of wire in plastic wire duct where practical.

E. All wiring runs shall be securely fastened to the panel or wire duct by means of plastic wire ties. Adequately support and restrain all wire runs to prevent sagging or movement.

F. AC power wiring and instrumentation/analog wiring shall be run separate.

G. Color code all internal wiring (not field wiring) as follows:

1. Line and load circuits: Black (B)
2. AC control wiring: Red (R)
3. Externally-Powered control wiring: Yellow (Y)
4. Neutral wiring: White (W)
5. Low voltage DC(+)pos: Blue (BL)
6. Low voltage DC(-)neg: Blue/White Tracer (BL/W)
7. Grounding: Green (G)

H. Terminal strips shall be provided for all input and output wiring. No more than two (2) wires shall be connected to one (1) terminal block.

2.10 ELECTRICAL SURGE AND TRANSIENT PROTECTION

A. General

1. Function: Protect the system against damage due to electrical surges.

B. Application: As a minimum, provide surge and transient protection (with proper grounding) at the following locations as described below:

1. Power Input High Frequency Noise Filtering:

a. 120VAC Control panels with integral UPSs, PLCs, or other electronic/microprocessor equipment that is susceptible to failure or improper operation due to high frequency/harmonic input transients shall be provided with series-connected high-frequency noise filters on the line input (downstream of any panel main disconnects/breakers). Filters shall be as manufactured by Edco/Emerson/Islatrol or equal (exact type(s) as required by application).

2. Power Input Surge Protection:

    a. Provide surge protection device at any connection of 120VAC power to panels containing programmable logic controllers, remote I/O equipment, UPS's, transmitters, radios, VFDs, Reduced Voltage Soft Starters or other electronic equipment. Device shall:

        1) Be mounted internal to the associated panel, with dedicated overcurrent protection.
        2) Be of two-part (base and SPD), DIN-rail mountable construction.
        3) Have 15kA total nominal discharge current per line (based on 8/20µs waveform).
        4) Have maximum continuous operating voltage (MCOV) rating as required by the associated circuit voltage.
        5) Visually indicate operational status.
        6) Be Dehn DEHNguard series or equal by MTL Technologies, or may be combined with the High Freqency Noise Filtering device required above.

    b. Provide surge protection device at any connection of multi-pole AC power to panels containing programmable logic controllers, remote I/O equipment, UPS's, transmitters, radios, VFDs, Reduced Voltage Soft Starters or other electronic equipment. Device shall:

        1) Be mounted internal to the associated panel, with dedicated overcurrent protection.
        2) Provide protection for all phases.
        3) Have 40kA (per phase) peak surge current rating.
        4) Have maximum continuous operating voltage (MCOV) rating as required by the associated circuit voltage.
        5) Visually indicate operational status.
        6) Be Square D SDSA or HWA series or equal.

3. Analog I/O Panel Terminations Surge Protection:

    a. Provide surge protection device at the PLC (or similar) panel connection of each analog I/O signal. Device shall:

        1) Be mounted internal to the associated panel.
        2) Be of two-part (base and SPD), DIN-rail mountable construction.
        3) Have the following nominal discharge current ratings:

            a) D1 Lightning impulse current (10/350 µs) per line: 1 kA
            b) C2 Total nominal discharge current (8/20 µs): 20 kA
            c) C2 Nominal discharge current (8/20 µs) per line: 10 kA

        4) Have maximum continuous operating voltage (MCOV) rating as required by the associated signal.
        5) Manufacturer and Model:

a) DEHN BSP M4 BE 24 (926 324) with 920300 base.
b) Phoenix Contact 2801263 with included base.
c) Weidmuller 1093400000 with 8951710000 base.

4. Discrete I/O Panel Terminations Surge Protection:

   a. Provide isolation relay at the PLC (or similar) panel connection of each discrete output signal (within the associated panel). See above for isolation relay requirements.

5. Low Voltage Power Supply Load Side Surge Protection:

   a. Provide surge protection device at the PLC (or similar) panel on the load side of each low voltage power supply that has low voltage connections extending external to the panel. Device shall:

      1) Be mounted internal to the associated panel.
      2) Be of two-part (base and SPD), DIN-rail mountable construction.
      3) Have 10kA total nominal discharge current per line (based on 8/20µs waveform).
      4) Have maximum continuous operating voltage (MCOV) rating as required by the associated utilization voltage.
      5) Be as manufactured by Dehn, MTL Technologies, or Phoenix Contact.

6. Network Panel Terminations Surge Protection:

   a. Provide surge protection device at the PLC (or similar) panel connection of each network cable. Device shall:

      1) Be mounted internal to the associated panel.
      2) Be of DIN-rail mountable construction.
      3) Have 1kA total nominal discharge current per line (based on 8/20µs waveform).
      4) Be designed specifically for the associated network connection type (Ethernet, RS485, RS232, etc.).
      5) Be MTL Zonebarrier series or equal.

7. Antenna Cable Terminations Surge Protection:

   a. Provide surge protection device at the connection of antenna cable to the radio panel. Device shall:

      1) Be mounted internal to the associated panel.
      2) Provide coarse protection via replaceable gas-filled surge voltage arrestor
      3) Be Phoenix Contact CN-LAMBDA series or equal.

C. Installation and grounding of suppressor: As directed by manufacturer. Provide coordination and inspection of grounding.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE & HANDLING

A. Provide Site and warehouse storage facilities for all equipment.

B. Prior to shipment, include corrosive-inhibitive vapor capsules in shipping containers, and related equipment as recommended by the capsule manufacturer.

C. Prior to installation, store items in dry indoor locations. Provide heating in storage areas for items subject to corrosion under damp conditions.

D. Cover panels and other elements that are exposed to dusty construction environments.

3.2 INSTALLATION

A. Provide enclosure mounting supports as required for floor, frame or wall mounting. All supports in exterior, wet or process areas shall be stainless steel unless noted otherwise. All floor-mounted panels or other similar distribution equipment shall be mounted on 6" concrete housekeeping pads unless specifically shown otherwise. The general design intent is that centers of control panels be mounted at heights that are easily accessible. Design intent is that devices on panel fronts (pushbuttons, selector switches, pilot lights, HMIs, ETMs, breaker handles, etc.) generally be mounted as close to 5'-0"a.f.f. as possible, no higher than 6'-7"a.f.f (per NEC requirements) and no lower than 3'-6"a.f.f., where possible, without specific approval of the owner or engineer. Additionally, every effort shall be made to provide a professional, consistent, neat, and workmanlike finished appearance of panel installations. For example, tops of adjacent panels shall be mounted at matching heights where possible/reasonable.

B. All enclosures used outside shall be solid bottom unless otherwise specified. All cable and piping openings shall be sealed watertight. Cable and piping shall enter the enclosure as shown on drawings or specified herein.

C. All equipment and components shall be solidly grounded to the control panel. One grounded terminal unit shall be provided in each control panel for connection to plant ground system. Grounding digital and analog components shall be performed in accordance with the instrument supplier's installation recommendations. Signal ground shall be solidly connected to the ground system so as to prevent ground loops

3.3 PAINTING

A. For enclosures other than NEMA 4X stainless steel or fiberglass:

1. Completely clean all surfaces so that they are free of corrosive residue. Then, phosphatize all surfaces for corrosion protection.
2. Prime with two (2) coats and finish with one coat of factory finish textured polyurethane. Paint shall be Sherwin-Williams Polane "T' or approved equal.
3. Color to be selected during shop drawing review phase.

3.4 IDENTIFICATION & DOCUMENTATION

A. Refer to specification section 26 05 53 for additional requirements.

B. Control panel power supply source, type, voltage, number or circuit ratings shall be identified inside control panels and on drawings.

C. All interior devices and components shall be identified with thermal transfer labels with black letters on white background. Labels shall be placed on the subpanel and not the component. Marking system shall be a Brother “PTouch II” or equal. Lettering shall be 1/4" high.

D. All front panel mounted devices such as push buttons shall be identified by the use of engraved bakelite nameplates or legend plates. Nameplates shall be 1/8” thick, white with black core.

E. Where a panel includes a touchscreen or other programmable HMI display and is to be monitored by another system (such as a plant SCADA system), the panel supplier shall provide copies of the HMI display code and screenshots of all proposed HMI screens to the other system supplier (such as the SCADA Integrator) for their use in duplicating the associated HMI.

F. A job-specific, custom wiring diagram for each control panel (not including control stations without relays) shall be provided to the contractor prior to installation for making the appropriate electrical connections. The wiring diagram shall clearly show all control components connected to the panel (whether the components are mounted internal or external to the enclosure). All wires and terminal blocks shall be clearly labeled. A laminated copy of the final wiring diagram for each unit shall be installed inside the door of the associated panel, and submitted to the owner with the as-built documentation.

3.5 OWNER TRAINING

A. Fully train the owner in the proper operation of all control panels/equipment, describing and demonstrating full operation, including function of each door-mounted device.

3.6 SPARE EQUIPMENT

A. Provide the following spare equipment:

1. Fuses: 10% (minimum of 3) of each size and type utilized, mounted within a pocket within the associated control panel.
2. Where control panel contains programmable controller (or similar equipment): Flash drive containing copies of all final programs utilized within the control panel, with provisions/cable assemblies as required to connect the flash drive provided to the controller to download the programs. Flash drive shall be attached to retractable cord (long enough to reach the associated port) attached to the inside of the panel door.

END OF SECTION 26 29 00

SECTION 26 29 16 – REDUCED VOLTAGE SOFT STARTERS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. These specification requirements are for solid state reduced voltage motor controllers rated 600VAC and below, herein referred to as soft starters.

B. They are for use with AC motors to reduce the current in-rush as well as mechanical shocks that can result from starting or stopping a motor across the line.

1.2 QUALITY ASSURANCE

A. The electronic “soft starter” shall be listed by an independent testing laboratory in accordance with UL 508 - Industrial Control Equipment.

B. The soft start shall carry the CE mark for indication of compliance to low voltage and EMC directives in accordance with EN / IEC 60947-4-2.

C. The manufacturer shall be a certified ISO 9001 facility.

1.3 SUBMITTALS

A. Submittals shall be furnished in accordance with Specification Section 16050.

B. Provide the following for each Soft Start unit:

1. A job-specific, custom wiring diagram

    a. The wiring diagram shall clearly show all control components connected to the starter (whether the components are mounted internal or external to the soft start enclosure).
    b. All wires and terminal blocks shall be clearly labeled.
    c. Diagram shall be in accordance with NEMA/ICS standards.

2. Size, type and rating of all system components.
3. Enclosure frontal elevation and dimension drawings.
4. Internal component layout diagrams.
5. Available conduit entry and exit locations.
6. Manufacturer’s product data sheets for all components.

C. Standard catalog sheets showing voltage, horsepower, maximum current ratings and recommended replacement parts with part numbers shall be furnished for each different horsepower rated Soft Starter shall be provided.

1.4 WARRANTY

A. An eighteen-month warranty shall be provided on materials and workmanship from the date of owner acceptance/substantial completion after completion of startup.

PART 2 - PRODUCT

2.1 MANUFACTURERS

A. The soft starter equipment shall be:

1. Square 'D'
2. Eaton / Cutler Hammer
3. Or pre-approved equal meeting the detailed requirements of this specification. Note that all "named" Manufacturers are obligated to meet the detailed requirements of this specification. Any proposed exceptions shall be clearly stated at bid time, citing the reason for noncompliance, and the cost for providing a conforming product. Failure to provide a detailed list of proposed exceptions may cause a bid to be deemed non-responsive. The Engineer will be the sole determiner of the acceptability of a proposed exception.

2.2 GENERAL DESCRIPTION

A. Refer to Specification Section 26 9 00 (Manufactured Control Panels) as applicable for additional requirements (for enclosure, component types, etc.).

B. The soft starter shall be provided complete with a main circuit breaker disconnect means for Type 1 short circuit overcurrent protection as follows:

1. Short circuit withstand rating shall be equal to or greater than the AIC rating listed on the plans for the distribution equipment (motor control center, panelboard, switchboard, etc.) that feeds the soft starter.
2. Sized by manufacturer per NEC requirements for corresponding motor load.

C. The motor shall be automatically protected from solid state component failure by the following means:

1. Isolation contactor that opens when the motor is stopped or when the controller detects a fault condition including a shorted SCR.

D. The soft starter shall utilize an SCR bridge consisting of at least two SCRs per phase to control the starting and stopping of industry standard motors.

1. SCR stacks shall be arranged horizontally for proper heat management.
2. Heat sinks sized for specified Starts Per Hour without requiring auxiliary cabinet cooling fans.

E. The soft start shall provide torque control for linear acceleration independent of motor load or application type without external feedback. The gating of the SCRs shall be controlled in such a manner to ensure stable and linear acceleration ramp.

F. The soft starter shall be controlled by a microprocessor that continuously monitors the current and controls the phasing of the SCRs. Analog control algorithms will not be allowed.

G. All soft starter power ratings shall utilize the same control board/module.

H. A shorting contactor shall be standard on soft starters in all enclosure configurations. Protective features and deceleration control options integral to the soft starter shall be available even when the shorting contactor is engaged.

2.3 MOTOR DATA

A. Each Soft Starter shall be sized to operate the AC motors defined to match load schedules and other specification documents as follows:

1. Motor Horsepower and voltage rating(s) – See electrical drawings and schedules.
2. Motor full load amperes, RPM and service factor ratings as stated within the individual motor specification documents.

B. The Soft Starter manufacturer shall be responsible for verifying each exact motor amperage, horsepower, voltage, RPM and service factor with motor equipment supplier prior to submitting shop drawings.

2.4 ENVIRONMENTAL RATINGS

A. The soft start shall be designed to operate in an ambient temperature 0°C to 40°C (14°F to 104°F). For ambient temperatures between 40°C and 60°C (104°F and 140°F), derate the current by 2% per °C above 40°C (104°F).

B. Storage temperature range shall be -25°C to 70°C (-13°F to 158°F).

C. Maximum relative humidity shall be 95%, non-condensing or dripping water, conforming to IEC 60947-4-2.

D. The soft starter shall be designed to operate in altitudes up to 1000m (3300 ft). For higher altitudes, derate by 2.2% for each additional 100 m (330 ft) with a maximum of 2000m (6600 ft).

2.5 ELECTRICAL RATINGS

A. The soft starter shall be capable of operation between + / - 10% of nominal voltage rating.

B. The soft start shall automatically adapt for operation at 50 or 60 Hz, with a frequency tolerance of +/- 5%. By configuration, it shall be capable of operation at a supply line frequency that can vary by +/- 20% during steady state operation.

C. The soft start unit amperage shall be the greater of the following:

1. 110% of the NEC amperage rating associated with the horsepower rating shown on the plans (for heavy duty Class 20 starting).
2. 100% of the unit amperage rating shown on the plans (for heavy duty Class 20 starting).

D. The soft start shall be capable of supplying 400% of rated full load current (of the soft starter) for 23 seconds at maximum ambient temperature. The soft starter shall also be capable of 10 evenly spaced starts per hour at 400% of full rated current (of the soft starter) for 12 seconds per start.

E. The soft start shall have a coordinated short circuit rating equal to or in excess of the minimum value

listed on the piece of distribution equipment that feeds the soft start. This rating shall be listed on the nameplate. When a power distribution system electrical study (including short circuit stud, etc.) is a part of the project, contractor shall further verify that all proposed equipment is properly rated (per the results of the study) prior to submitting shop drawings.

F. The SCRs shall have a minimum P.I.V. rating of 1800 Vac. Lower rated SCRs with MOV protection are not acceptable.

G. A seismic qualification label shall be provided for all wall and floor mount units to comply with the latest IBC and NFPA 5000 guidelines where installed in seismic zones C, D, E or F.

2.6 ADJUSTMENTS AND CONFIGURATIONS

A. All programming/configuration devices, display units, and field control wiring terminals shall be accessible on the front of the control module. Exposure to control circuit boards or electrical power devices during routine adjustments is prohibited.

B. Digital indication shall provide, as a minimum, the following conditions:

1. Soft starter status - ready, starting/stopping, run.
2. Motor status - current, torque, thermal state, power factor, operating time, power in kW.
3. Fault status - Motor thermal overload, soft starter thermal fault, loss of line or motor phase, line frequency fault, low line voltage fault, locked rotor fault, motor underload, maximum start time exceeded, external fault, serial communication fault, line phase reversal fault, motor overcurrent fault.

C. The soft starter shall be preset to the following for adjustment-free operation in most applications:

1. Linear (torque-controlled) acceleration ramp of 15 seconds.
2. Current limitation to 300% of the motor full load current rating.
3. Class 10 overload protection.
4. Motor current preset per NEC / NFPA 70 table 430.150 for standard hp motors.

D. The exact acceleration ramp time/type, current limitation, overload protection type and motor current shall be set in the field by the startup technician prior to equipment startup as recommended/approved by the motor supplier.

E. A digital keypad shall be utilized to configure the following operating parameters as required:

1. Motor full load amps adjustable from 40 to 130% of the soft starter's rating.
2. Current limitation on starting adjustable from 150 to 700% of the motor current rating, not to exceed 500% of the soft starter rating.
3. Linear (torque-controlled) acceleration ramp adjustable from 1 to 60 seconds.
4. Initial torque adjustable from 10 to 100% of nominal motor torque.
5. Torque limit adjustable from 10 to 200% of nominal motor torque.
6. Maximum start time adjustable from 10 to 999 seconds.
7. Voltage boost adjustable from 50 to 100% of the nominal supply voltage.
8. Selection of freewheel, soft stop or braking.
9. Linear (torque-controlled) deceleration ramp time adjustable from 1 to 60 seconds.

10. Threshold to change to freewheel from a controlled deceleration ramp to freewheel stop: adjustable from 0 to 100% of the nominal motor torque.
11. Braking torque level adjustable from 0 to 100% effectiveness.
12. Selection of Class 2, 10, 10A, 15, 20, 25 or 30 motor thermal overload protection.

F. A digital keypad shall be utilized to configure the following controller parameters as required:

1. Selectable automatic reset operation.
2. Cancellation of the torque control loop for multi-motor installations.
3. Adjustment of the stator loss estimation for specialty motors.
4. Assignment of soft starter inputs and output control terminals.
5. Activation of line phase reversal protection.
6. Reset of motor thermal state.
7. Return to factory settings.
8. Activation of test mode for use with low power motors.
9. Indication of elapsed time in hours of starting, running and stopping.

G. Output relays shall provide the following status indications:

1. One Form A (N.O.) minimum for indication of fault.
2. One Form A (N.O.) for indication that acceleration ramp is complete and current is below 130% motor FLA (end of start).
3. One Form A (N.O.) assignable to one of the following functions: motor thermal alarm, motor current level alarm or motor underload alarm.

H. Additional inputs and outputs shall be available to provide the following status indications:

1. Two assignable control inputs for the following functions: force to freewheel stop, external fault input, disable serial link control, external motor overload reset or general fault reset.
2. Two assignable logic-level signal outputs for the following functions: motor thermal overload alarm, “motor powered” signal, motor overcurrent alarm, or motor underload alarm.
3. One analog output shall be available for 4 to 20 milliamp indication of motor current, motor torque, motor power, motor thermal state, or power factor.
4. Other inputs/outputs as shown on electrical drawings.

I. Relay and I/O functions listed above shall be isolated with respect to common.

2.7 PROTECTION

A. A microprocessor-based thermal protection system shall be included which continuously calculates the temperature-rise of the motor and soft starter and provides:

1. A motor overload pre-alarm that indicates by relay contact or logic output that the motor windings have exceeded 130% of its rated temperature rise. This function shall be for alarm only.
2. A motor overload fault shall stop the motor if the windings have exceeded 140% of temperature-rise.

3. An electronic circuit with a time-constant adjustable to the motor's thermal cooling time-constant ensuring the memorization of the thermal state even if power is removed from the soft starter.

B. The soft starter shall provide line and motor phase loss, phase reversal, underload, stall, and jam protection.

C. The integral protective features shall be active even when the shorting contactor is used to bypass the SCRs during steady state operation.

2.8 CONTROL OPTIONS

A. The soft starter control circuit shall be fed from the line supply and be completely independent of the power circuit and separate from the control logic.

B. The peripheral soft starter control circuitry shall be operated at 120 Vac 60 Hz from a control power transformer included within the enclosure.

C. Operator devices shall be door mounted, functions/types as shown on drawings.

D. All operator devices shall be remote-mounted using supplied 120 Vac control logic. Clearly labeled terminals shall be provided for field installation.

E. All wiring shall be clearly identified on each end to match the wiring diagram(s) provided with the soft starter.

F. Refer to Specification Section 16443 (Motor Control Centers) or Specification Section 16480 (Manufactured Control Panels) as applicable for all operator device and control component requirements (for pushbuttons, indicator lights, selector switches, relays, control wiring, etc).

2.9 COMMUNICATIONS

A. The RVSS shall be able to be connected to communication network type(s) as indicated on plans or required by the SCADA Integrator (exact network/protocol type(s) required shall be as directed by the facility SCADA Integrator). Where no specific network connections are specified on plans or required by the SCADA Integrator, the RVSS shall be provided with at least one of the following network communication options:

a. Modbus RTU serial
b. Ethernet TCP/IP
c. Ethernet IP

B. The communication shall be able to provide access to the control, to the adjustment and to the supervision of the soft starter.

C. No additional compensation will be granted to provide gateways, network components, etc. to properly communicate with the facility SCADA system. Equipment supplier is responsible for verifying all network connection requirements with the SCADA Integrator prior to bid.

2.10 INPUT SURGE PROTECTION

A. Each RVSS that does not have an upstream isolation contactor, and is not mounted within an MCC that has its own main bus surge protection shall be provided with a 3-phase, line-side surge protection device rated 80kA (per phase) or greater. The lead length between the surge protection device and the drive terminals shall be 12" or less. The surge protection device shall be designed / located / isolated such as to prevent / limit potential physical damage to other components within the enclosure if the surge protection device fails.

2.11 SHORTING CONTACTOR

A. A microprocessor shall control the operation of the shorting contactor via an output relay.

B. The shorting contactor shall close, shorting the SCRs after the acceleration ramp is compete and motor current is below 130% of motor FLA, and open on a stop command to allow a deceleration ramp.

C. Overload protection integral to the soft starter shall continue to protect the motor when shorting is engaged.

2.12 ISOLATION CONTACTOR

A. An IEC or NEMA-rated isolation contactor shall be provided that opens when the motor is stopped or when the controller detects a fault condition including a shorted SCR.

B. The isolation contactor shall be located on the line side of the associated controller.

PART 3 - EXECUTION

3.1 TESTING

A. All incoming material shall be inspected and/or tested for conformance to quality assurance specifications.

B. Power semiconductors shall be fully tested for proper electrical characteristics, including dv/dt and di/dt.

C. All subassemblies shall be inspected and/or tested for conformance to quality assurance specifications.

D. Each completed unit shall be functionally tested prior to shipment to assure conformance to the specifications.

3.2 DELIVERY, STORAGE AND HANDLING

A. Handling and shipment of the equipment shall be in such a manner to prevent internal component damage, breakage, and denting and scoring of the enclosure finish.

B. Equipment shall be stored indoors in a clean, dry environment as directed by the equipment supplier. Energize anti-condensation space heaters if so required.

1. Verify that the location is ready to receive work and the dimensions are as indicated.

2. Do not install Soft Starter equipment until the building environment can be maintained within the service conditions required by the manufacturer.

3.3 INSTALLATION

A. Installation shall comply with manufacturer's instructions, drawings and recommendations.

B. A job-specific, custom wiring diagram for each soft start unit shall be provided to the contractor prior to installation for making the appropriate electrical connections. The wiring diagram shall clearly show all control components connected to the starter (whether the components are mounted internal or external to the soft start enclosure). All wires and terminal blocks shall be clearly labeled. A laminated copy of the final wiring diagram for each unit shall be installed inside the door of the associated unit.

C. Operations and Maintenance Manuals shall be provided to the owner for all Soft Starter components, control wiring, etc.

D. Operations and Maintenance Manuals shall include hardcopy printouts of all device settings and programming.

E. For safety, reliability, and continuity of warranty, any modifications, alterations, etc. required to conform to the requirements of this specification shall be performed by the Starter manufacturer only. Distributor modifications, third party packaging, etc. of a manufacturer’s standard product are specifically disallowed.

3.4 START UP AND TRAINING

A. The services of a qualified manufacturer's service representative shall be available to install, test, and start up all soft starts furnished under this specification. The schedule of the startup(s) shall be determined by the contractor.

B. Services shall include a minimum of eight (8) hours of field/classroom training for owner’s personnel on routine operation and maintenance of the specified units.

3.5 SPARE PARTS

A. The following spare parts shall be provided at no extra cost to the Owner:

1. One of each type and size of control fuse.
2. Three of each type and size of power fuse.

END OF SECTION 26 29 16

SECTION 26 44 00 - ELECTRICAL HEAT TRACING SYSTEMS

PART 1 - GENERAL

1.1 SCOPE

A. This specification covers the requirements of materials and support services for heat-tracing systems. Heat tracing systems (including insulation and all accessories) shall be provided on all piping installed exposed in exterior locations or where otherwise indicated on plans unless noted otherwise.

1.2 CODES, APPROVALS, AND STANDARDS

A. The electric heat-tracing system shall conform to this specification. It shall be designed, manufactured, and tested in accordance with the applicable requirements of the latest edition of the following codes and standards.

1. ANSI American National Standards Institute
2. CEC Canadian Electrical Code
3. CSA CSA International
4. FM FM Approvals
5. IEC International Electro-Mechanical Commission
6. IEEE Institute Of Electrical and Electronics Engineers
7. ITS Intertek Testing Services (Intertek ETL SEMKO)
8. NEC U.S. National Electrical Code (NFPA 70)
9. NEMA National Electrical Manufacturers Association
10. NESC National Electrical Safety Code
11. UL Underwriters' Laboratories, Inc.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Heat Tracing:

1. Raychem/Tyco Thermal Controls.
2. Thermon.
3. Nelson Heat Tracing.
4. Chromalox.

B. Insulation:

1. Armstrong World Industries, Inc.
2. Babcock & Wilcox; Insulationg Products Division
3. CertainTeed Corporation

4. Knauf Fiber Glass GmbH
5. Manville Products Corp.
6. Owens-Corning Fiber Glass Corp.
7. Pittsburg Corning Corp.
8. Rubatex Corp.

2.2 SELF-REGULATING HEATING CABLES

A. All heat-tracing applications with continuous exposure (maintain) temperatures from 150°F (65°C) to 250°F (121°C) or intermittent exposure temperatures from 185°F (85°C) to 420°F (215°C) shall use self-regulating cables.

1. Self-regulating heating cable shall vary its power output relative to the temperature of the surface of the pipe or the vessel. The cable shall be designed such that it can be crossed over itself and cut to length in the field.
2. Self-regulating heating cable shall be designed for a useful life of 20 years or more with "power on" continuously, based on the following useful life criteria:

    a. Retention of at least 75 percent of nominal rated power after 20 years of operation at the maximum published continuous exposure (maintain) temperature.
    b. Retention of at least 90 percent of nominal rated power after 1000 hours of operation at the maximum published intermittent exposure temperature. The testing shall conform to UL 746B, IEC 216-1 Part 1.

3. A warranty against manufacturing defects for a period of 10 years shall be available.
4. All cables shall be capable of passing a 2.5 kV dielectric test for one minute (ASTM 2633) after undergoing a 0.5 kg-m impact (BS 6351, Part 1, 8.1.10).

2.3 FREEZE-PROTECTION SYSTEMS

A. The heating cable shall consist of two 16 AWG or larger nickel-plated copper bus wires, embedded in a self-regulating polymeric core that controls power output so that the cable can be used directly on plastic or metallic pipes. Cables shall have a temperature identification number (T-rating) of T6 (185°F or 85°C) without use of thermostats.

B. The heating cable shall have a tinned copper braid with a resistance less than the heating cable bus wire resistance as determined in type test (ASTM, B193, Sec. 5). The braid shall be protected from chemical attack and mechanical abuse by a modified polyolefin or fluoropolymer outer jacket.

C. In order to provide rapid heat-up, to conserve energy, and to prevent overheating of fluids and plastic pipe, the heating cable shall have the following minimum self-regulating indices:

1. Table K.1 Minimum Self-Regulating Indices

Heating cable	S.R. index (W/°F)	S.R. Index (W/°C)
3 W/ft	0.038	0.068
5 W/ft	0.060	0.108
8 W/ft	0.074	0.133

10 W/ft	0.100	0.180

D. The self-regulating index is the rate of change of power output in watts per degree Fahrenheit or watts per degree Celsius, as measured between the temperatures of 50°F (10°C) and 100°F (38°C) and confirmed by the type test and published data sheets.

1. In order to ensure that the self-regulating heating cable does not increase power output when accidentally exposed to high temperatures, resulting in thermal runaway and self-ignition, the cable shall produce less than 0.5 watts per foot (1.64 watts per meter) when energized and heated to 350°F (177°C) for 30 minutes. After this test, if the cable is reen-ergized, it must not have an increasing power output leading to thermal runaway.
2. In order to confirm 3.1B, the self-regulating heating cable shall retain at least 90 percent of its original power output after having been cycled 300 times between 50°F (10°C) and 210°F (99°C), allowing at least six minutes of dwell time at each temperature.
3. The heating cable shall be Raychem® BTV-CT or BTV-CR self-regulating heater, with continuous exposure (maintain) capability up to 150°F (65°C) and intermittent exposure capability up to 185°F (85°C), as manufactured by Tyco Thermal Controls.

2.4 SYSTEMS FOR DIVISION 1 HAZARDOUS LOCATIONS

A. The following requirements shall apply in addition to the criteria specified above:

1. The self-regulating heating cable shall be specifically FM Approved or CSA Certified for use in Division 1 locations.
2. A ground-fault protection device set at 30 mA, with a nominal 100 ms response time, shall be used to protect each circuit.
3. The temperature identification number (T-rating) of the cable used shall comply with FM and CSA requirements as applicable.
4. Connection methods used with the cable shall be compatible and approved as a part of the system manufactured and supplied by the heating cable vendor for use in the Division 1 location.
5. For plastic pipe and vessel applications, the heating cable shall be Raychem HBTV-CT or Raychem BTV-CT self-regulating heaters, with continuous exposure capability up to 150°F (65°C) and intermittent exposure capability up to 185°F (85°C), as manufactured by Tyco Thermal Controls.
6. The heating cable shall be Raychem HQTV-CT or Raychem QTVR-CT self-regulating heaters, for continuous and intermittent exposure capability up to 225°F (110°C), as manufactured by Tyco Thermal Controls.

B. Terminations for nonhazardous And hazardous class 1, div 2 locations

1. All connection components used to terminate heating cables, including power connectors, splices, tees, and connectors shall be approved for the respective area classification and approved as a system with the particular type of heating cable in use. Under no cir-cumstances shall terminations be used which are manufactured by a vendor other than the cable manufacturer.
2. In order to keep connections dry and corrosion resistant, components shall be constructed of nonmetallic, electrostatic, charge-resistant, glass-filled, engineered polymer enclosure

rated NEMA 4X. The component stand shall allow for up to four inches (100 mm) of thermal insulation.

3. Terminals shall be spring clamp wire connection type to provide reliable connection, maintenance-free operation, and ease of reentry.
4. Heating cable terminations shall use cold-applied materials and shall not require the use of a heat gun, torch, or hot work permit for installation.
5. Components shall be rated to a minimum installation temperature of –40°F (–40°C), minimum usage temperature of –75°F (–60°C), and maximum pipe temperature of 500°F (260°C).
6. The component system shall be Raychem JBM-100-L-A connection kit complete with integral LED power indicating light to serve as complete power, splice, or tee connection for up to three Raychem BTV, QTVR, or XTV industrial parallel heating cables as manufactured by Tyco Thermal Controls.

2.5 THERMOSTATS AND CONTACTORS

A. Freeze protection systems shall operate using self-regulating control or with the DigiTrace AMC-1A or DigiTrace AMC-F5 thermostat and the DigiTrace E104-100A or DigiTrace E304-40A contactor in nonhazardous locations, and DigiTrace AMC-1H thermostat with Digitrace E307-40A contactor in hazardous locations, as supplied by Tyco Thermal Controls.

B. Where heat tracing is applied to emergency showers and/or emergency eye wash systems (or other systems where the heated piping system provides water that may be applied to persons in emergency or non-emergency situations), the sensor (that determines whether the heat tracing system is ON or OFF) shall be placed on the associated pipe or tank wall rather than in ambient air (such as to prevent the heat tracing system from overheating the associated liquid).

2.6 END SEAL

A. An above-insulation, lighted end seal kit shall be provided for each heat trace circuit termination as per the manufacturer’s installation details. The kit shall be E-100-LBTV2 as supplied by Tyco Thermal Controls.

2.7 INSULATION

A. All components of the insulation, including covering, mastics and adhesives shall have a flame-spread rating of not over 25, and a smoke development rating of not over 50. Ratings shall be as established by tests in accordance with ASTM E 84 and Federal Specification standards. The integrated insulation assemblies shall also conform to the above specifications. Insulation shall be applied in strict accordance with the manufacturer's instructions.

B. Description:

1. This type of insulation shall be employed for process, cold-and hot water, steam, and condensate piping and equipment with surface temperatures up to 850 degrees F. Pipe insulation and jacketing shall be applied to piping where shown, and shall include fittings, flanges, and valves. Pipe insulation shall be molded-type pipe covering, made of fibrous

glass with a minimum k-factor of 0.23 at 75 degrees F mean temperature. Unless otherwise specified the insulation thickness shall be 1" minimum.

2. The insulation shall be oversized for installation over electric heating cable. Insulation shall have a factory-applied white fire-retardant vapor-barrier jacket of kraft paper and aluminum foil laminated together and reinforced with fiberglass yarn. Fittings and valves shall be covered with the same material as the pipe, cut in segments to fit snugly without open spaces, held in place with copper wire or cement, and then covered with the same jacketing material as the pipe. Insulated fittings adjacent to vapor-barrier insulation shall be sealed with an acceptable vapor-barrier cement before installation of the finish jacket. Pipe insulation and vapor-barrier shall be continuous through hangers and supports. Insulation shall be coordinated with the pipe hangers and supports and where insulation protection shields are provided the top half section of pipe insulation at support locations shall be of the same specified density, and the bottom half insulation segments provided between the pipe and the insulation protection shields shall have a density of not less than 6 lb/cu ft. All insulation shall be covered with smooth aluminum weatherproof metal or plastic preformed jacketing with a factory attached moisture barrier. The jacket for the fittings shall consist of precision-formed smooth-sided sections and shall be sized to cover and protect the insulated fitting. Each section shall be manufactured from aluminum or PVC, and all joints shall be sealed with silicon mastic or solvent welding, to provide a continuous, air and weathertight joint. Strapping shall be 1/2-inch wide, Type 3003 aluminum or stainless steel.

PART 3 - EXECUTION

3.1 GENERAL

A. Heat tracing shall be provided along full length of all exposed piping or vessels located outside of buildings or in other areas designated on plans (such as by insulated piping in areas subject to cold temperature). Insulation shall be provided over all heat traced pipes.

B. The vendor shall provide a detailed design utilizing standard heat-tracing design software, such as Tyco Thermal Controls TraceCalc® Pro design software or equal. At minimum, the design must provide the following:

1. Circuit identification number
2. Maintain temperature
3. Line size and insulation
4. Heat loss for pipe, valves, and supports
5. Amount and type of heating cable required
6. Spiral requirements
7. Heating cable service voltage
8. Heating cable power output at the maintain temperature
9. Minimum and maximum maintain temperature vs. minimum and maximum ambient temperatures
10. Circuit breaker and transformer sizing

C. A ground-fault protection device set at 30 mA, with a nominal 100-ms response time, shall be used to protect each circuit.

D. Install additional heating tape at bolted flanges, valves, pipe supports, and other fittings and fixtures as recommended by supplier, but not less than the following:

1. Bolted flanges (per pair): Two times pipe diameter
2. Valves: Four times valve length
3. Pipe hanger or support penetrating insulation: Three times pipe diameter

E. The entire system shall be installed in compliance with the manufacturer's recommendations for a fully-functional, code-compliant system.

F. All insulation shall be installed by a qualified insulation contractor in strict accordance with the manufacturer's recommendations and the requirements of these specifications.

G. All piping insulation shall be installed following required testing and approval of piping.

3.2 IDENTIFICATION

A. Heat tracing systems shall be labeled at the field connection of power to the heat tracing equipment per the requirements for Utilization Equipment within Specification Section 26 05 53.

B. Heat traced piping, vessels, etc. shall be identified with appropriate caution signs or markings at intervals not exceeding 20 feet on center per NEC requirements.

3.3 TESTING

A. Factory inspections and tests for self-regulating, power limiting, series constant wattage and constant wattage (MI) heater cables shall include but are not limited to the following:

1. Testing shall be done per the latest IEEE Std. 515 test section and applicable manufacturer's standards.
2. In the field, all heater cables shall be meggered. The following separate field megger readings shall be taken on each self-regulating and each M.I. heater cable:

    a. Heater cable shall be meggered when received at jobsite before installation.
    b. Heater cable shall be meggered after installation, but before insulation is applied.
    c. Heater cable shall be meggered after insulation has been installed.

3. All three of the above field megger readings shall be greater than 20 megohms. Otherwise, the heater cable is not acceptable and shall be replaced.
4. Field megger tests shall be recorded for each heater cable, and certified reports shall be submitted to the user.

END OF SECTION 26 44 00

SECTION 27 05 00 - AUXILIARY SYSTEM CABLES, 0-50V

PART 1 - GENERAL

1.1 DESCRIPTION

A. Cables rated for 0V-50V application

PART 2 - PRODUCTS

2.1 GENERAL

A. Unless specified otherwise, all cables within the scope of this specification section shall:

1. Be rated for exposed cable tray installation.
2. Be plenum rated (Class 1 Control cabling and Instrumentation cabling installed in conduit or exposed in cable tray in non-plenum areas is not required to be plenum-rated).
3. Be UL-rated for the proposed application.
4. Be multi-conductor with overall outer sheath as required by the application. The insulation of each conductor within the overall multi-conductor cable shall be uniquely color-coded. Ground conductors (when provided) within the multi-conductor cable shall have green insulation. Conductors with green insulation shall not be used for conductors other than ground.
5. Utilize copper conductors.
6. Have wire gauge as required to limit voltage drop to acceptable limits determined by the system supplier and to meet all applicable code requirements.
7. Where installed underground, within slab-on-grade or in exterior locations, be rated for wet locations.
8. Where required for specific systems, meet the specific requirements (conductor quantity, wire gauge, insulation type, shielding, etc.) of the system supplier.

2.2 INSTRUMENTATION CABLING

A. In addition to above requirements, and unless specified otherwise, Instrumentation cabling shall:

1. Be #16awg minimum.
2. Be rated for 300V.
3. Have aluminum foil shielding.
4. Have stranded, twisted conductors.
5. Have PVC insulation/jacket with ripcord.
6. Be manufactured by Belden, AlphaWire or General Cable.

2.3 CLASS 1 CONTROL CABLING (120VAC CONTROL CIRCUITS, ETC.)

A. In addition to above requirements, and unless specified otherwise, Class 1 control cabling shall:

1. Be rated for 600V.
2. Be industrial grade.
3. Have stranded conductors.
4. Have sunlight/oil-resistant PVC/Nylon insulation and jacket with ripcord.
5. Be manufactured by Belden, AlphaWire or General Cable.

2.4 CLASS 2 & 3 CONTROL CABLING (FED FROM CLASS 2 OR 3 POWER SUPPLIES)

A. In addition to above requirements, and unless specified otherwise, Class 2 & 3 control cabling shall:

1. Be rated for 300V.
2. Be shielded if so recommended by the system supplier/integrator.
3. Have twisted conductors.
4. Have plenum-rated insulation/jacket with ripcord.
5. Be manufactured by AlphaWire, Belden, General Cable, Superior Essex or West Penn.

2.5 NETWORK CABLING

A. Furnish and install all Ethernet, Fiber Optic and Backbone Copper Telephone cabling in accordance with all BICSI requirements and in accordance with other applicable specification sections.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. Routing:

1. All wires and cables shall be installed in conduit unless specifically noted otherwise. Where conduit is not otherwise required by contract documents, 0-50V Cabling located within concealed, accessible ceiling spaces (such as above lay-in ceilings) may be run without conduit if the following requirements are met:

a. Cabling is plenum-rated, multi-conductor.
b. Cabling is supported by cable tray or with J-hook supports on intervals not to exceed 5’-0” on center. Cabling shall be supported solely from the cable tray or j-hooks supported from the building structure, without using piping, ductwork, conduit or other items as supports.
c. Cabling is neatly formed, bundled and tied with plenum-rated Velcro straps on intervals not to exceed 30” on center.
d. Properly-sized conduit(s) are provided wherever cabling enters an inaccessible or exposed area (such as above gyp board ceilings, within walls or through walls).

e. Cabling is not a part of a Fire Alarm System, Smoke Control System, Emergency Generator Control System or other life-safety related system.

2. End bushings shall be provided on both ends of all raceway terminations.
3. No splices shall be pulled into conduit.
4. No cabling shall be pulled until conduit is cleaned of all foreign matter.

B. Penetrations:

1. All fire/smoke barrier penetrations shall be made in accordance with a U.L. listed assembly.
2. For cabling not installed in conduit:

a. Fire/smoke barrier penetrations shall be sealed utilizing an enclosed fire-rated pathway device (STI EZ Path or equal) containing a built-in fire sealing system sufficient to maintain the hourly fire rating of the barrier being penetrated. The self-contained sealing system shall automatically adjust to the installed cable loading and shall permit cables to be installed, removed or retrofitted without the need to remove or reinstall firestop materials. The pathway shall be UL Classified and tested to the requirements of applicable ASTM/UL1479 standards.

3. For cabling installed within conduit from endpoint to endpoint:

a. Fire/smoke barrier penetrations shall sealed utilizing fire caulk or other equivalent firestop systems around perimeters of conduits per UL requirements.

4. For cabling installed within cable trays:

a. Fire/smoke barrier penetrations shall be sealed with one of the following methods:

1) Continuous cable tray through the penetration, with a combination of large firestop pillows and small firestop pillows contained, supported and secured (to prevent unauthorized removal) on both sides by aluminum wire mesh and firestop putty. Firestop pillows shall be STI Series SSB or equal and Firestop putty shall be STI Spec Seal or equal.
2) Cable tray broken at the penetration, with fire/smoke barrier penetrations sealed utilizing an enclosed fire-rated pathway device (STI EZ Path or equal) containing a built-in fire sealing system sufficient to maintain the hourly fire rating of the barrier being penetrated. The self-contained sealing system shall automatically adjust to the installed cable loading and shall permit cables to be installed, removed or retrofitted without the need to remove or reinstall firestop materials. The pathway shall be UL Classified and tested to the requirements of applicable ASTM/UL1479 standards.

C. Excess Cabling:

1. Excess cabling shall be neatly coiled within all junction boxes, pullboxes, wireways, etc. and at all terminations as required to allow future re-termination of cabling.

D. Terminations:

1. All conductors/cabling (including spare conductors) shall be properly terminated unless specifically directed otherwise. See below for general termination hardware requirements.
2. Cabling shall be neatly formed, bundled and tied at all terminations.

3.2 SPLICES/CONNECTIONS/TERMINATIONS:

A. Network Cabling:

1. Network and fiber optic cabling shall be continuous from endpoint to endpoint and shall not be spliced unless specifically noted otherwise.

B. Control Cabling:

1. Connections shall be made with T & B Sta-Kon wire joints EPT66M, complete with insulating caps. To be installed with WT161 Tool or C nest of WT11M Tool, Ideal Super - Nuts (not wire nuts), Ideal Wing Nuts, or Buchanan Elec. Products B Cap or Series 2000 Pressure connectors complete with nylon snap on insulators to be installed with C24 pressure tool.

C. Shielded cabling:

1. Unless directed otherwise by the system supplier, 0-50V cable shielding shall be grounded at the PLC/control panel end only (not at the field device end) with a termination kit as directed by the PLC/control panel supplier.
2. Shielded cabling shall be continuous from endpoint to endpoint and shall not be spliced without prior written approval from the Engineer.

3.3 LABELING

A. Refer to Specification Section 26 05 53 for all labeling requirements.

END OF SECTION 27 05 00

SECTION 27 60 00 - SCADA SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work included: Provide a complete SCADA System with instrumentation and controls with appurtenant equipment and accessories as indicated, specified, and as necessary for a complete and proper operating system.

1. Work includes, but not necessarily limited to, the following:

a. All programmable logic controllers (PLCs), instruments, and other appurtenances as indicated and specified herein and as required by the process flow and instrumentation diagrams and descriptions.
b. All engineering, hardware and software development, installation, startup, calibration services and supervision necessary.
c. Testing and operational demonstrations as specified.
d. Training programs as specified.
e. Preparation of manuals.
f. Programming of screens, alarms, historian, trending, etc. for the SCADA Computer system.

B. Related work:

1. Documents affecting work of this Section include, but are not necessarily limited to, General Specifications, Special Provisions, and all other related Sections.
2. Refer to Specification Section 26 29 00 for additional control panel requirements.
3. Refer to Specification Section 27 60 05 for instrumentation requirements.
4. Refer to plans for point lists and additional device requirements.

1.2 QUALITY ASSURANCE

A. The qualifications and experience of key project personnel shall be acceptable to the Engineer. The System Integrator shall employ competent service personnel to service and troubleshoot the control and instrumentation systems and shall have at least 15 years of experience with similar work. References shall be provided upon request by the Engineer. The System Integrator shall maintain their own UL508 panel shop. The geographic location of a fully staffed office with Engineers, Service Personnel, and programmers shall be within a150 mile radius of the project site. The System Integrator approved for this project is:

1. Dexter Fortson Associates – Birmingham, Alabama (contact Tim McGee: 205-531-5359)

B. The system integration duties shall be provided by a company qualified, experienced, and regularly engaged in designing, setting up, programming, and integrating complex process loop controls and instrumentation for process control and monitoring applications. Only qualified system integrators will be allowed to submit proposals for this project. In order to be

considered qualified, integrator shall have completed a minimum of five (5) projects of similar type/scope and equal or greater magnitude and complexity within the last ten (10) years. Sub-contractors without qualifications will be rejected. Previous projects used to meet this experience requirement must have included similar (or greater) scopes of work for each of the following areas:

1. Process loop controls for the proposed processes
2. HMI graphics
3. Instrumentation
4. Control Panel/PLC panel construction

C. Contractor:

1. Shall be fully and solely responsible for the work of the systems supplier and solely responsible to the Owner for having supplied to the Owner the complete integrated SCADA system.
2. To provide personal superintendence and direction of the work, maintaining and supplying complete supervision over and coordination between all subcontractors employed by him and the Instrumentation and Control System Integrator.
3. To be responsible for defining the limits of his subcontractor's work.
4. To be responsible for setting of instruments (including alarms, etc. as provided under other sections).

D. Operation and Maintenance Manuals

1. Operating instructions shall incorporate a functional description of the entire system, including the system schematics which reflect “as-built” modifications.
2. Special maintenance requirements particular to the system shall be clearly defined along with special calibration and test procedures.
3. As part of the operation and maintenance manuals, provide one hard copy of the program used to program the programmable logic controller.

1.3 WARRANTY

A. Systems supplier shall furnish a hardware and software warranty for the system starting at substantial completion and ending one year from this date.

1.4 REFERENCES

A. Instrument Society of America (ISA) PR7. 1, Pneumatic Control Circuit Pressure Test, Tentative Recommendation Practice.

B. Instrument Society of America (ISA) S5.4, Instrument Loop Diagrams, standard.

C. National Electrical Manufacturers Association (NEMA) Publication, General Standards for Industrial and Control Systems, ICS 1 and Industrial Controls and Systems ICS2.

1.5 SUBMITTALS

A. General/System submittal requirements:

1. Provide submittal (quantity as required by contract) of:

a. Component manufacturing data sheets indicating pertinent data and identifying each component (including all components within PLC/control panel enclosures, instruments, computer systems, surge protection devices, antennae, radios, sun/rain shields, etc.) by tag number and nomenclature as indicated on drawings and in specifications.
b. Component drawing showing dimensions, mounting, and external connection details

2. Identify any specification section where exceptions are being taken or an "or equal" piece of hardware is being proposed.
3. A Bill of Materials shall be included with catalog information on all components.
4. Information shall be included on any proprietary logic component sufficient to demonstrate its ability to perform the required functions.

B. Panel submittal requirements:

1. A job-specific, custom wiring diagram

a. The wiring diagram shall clearly show all components (whether the components are mounted internal or external to the control panel enclosure).
b. All wires and terminal blocks shall be clearly labeled.
c. Diagram shall be in accordance with NEMA/ICS standards.

2. Size, type and rating of all system components.
3. Unit frontal elevation and dimension drawings.
4. Internal component layout diagrams.
5. Manufacturer’s product data sheets for all components.

C. Instrumentation/Field Device submittal requirements:

1. Manufacturer’s product data sheets
2. Job-specific model numbers for each instrument/field device
3. Job-specific ranges/setpoints/etc. proposed for each instrument/field device

D. Computer System submittal requirements:

1. Manufacturer’s product data sheets
2. Job-specific model numbers and bill of materials for all computer system devices and software.
3. Screen shots showing proposed layout of each specific or typical SCADA HMI screen.

E. Calculation submittal requirements:

1. Load calculations showing the sizing of all power supplies provided (with spare capacity as specified).
2. Load calculations showing the sizing and anticipated runtime of all Uninterruptible Power Supply systems provided (with spare capacity as specified).

1.6 DELIVERY, STORAGE AND HANDLING:

A. Packing and Labeling:

1. Prior to shipment, each component shall be tagged to identify its' location, tag number, and system function. Identification shall be prominently displayed on the outside of the package.
2. Firmly attach permanent, final labeling (as specified elsewhere) to all equipment, panels, instruments/field devices, etc. prior to installation.

B. Delivery:

1. Following completion of shop assembly, factory test, and approval of all equipment by the Engineer, the panels, cabinets, and consoles and equipment shall be shipped. Provide protection for equipment from handling and the environment.

C. Receiving:

1. The contractor is responsible for receiving and proper storage of equipment delivered to the job site.
2. All received items shall be protected from the elements and where required stored in a low humidity environment.
3. Protect materials and equipment against damage in storage and during construction.

PART 2 - PRODUCTS

2.1 GENERAL:

A. Refer to Specification Section 26 29 00 (Manufactured Control Panels) for all control panel enclosure, control component, controller, surge protection device, etc. requirements.

B. Specifications below identify general intent and major system components only. System Integrator shall be responsible providing all system accessories, interconnections, installation, etc. and verifying compatibility of all system components as required to provide a fully-functional/coordinated system.

2.2 SCADA COMPUTER SYSTEMS & SCADA SOFTWARE

A. Reuse/Modify existing SCADA Computer Systems and SCADA Software as required.

2.3 MODIFICATIONS TO SCADA PLC/RTU PANELS SHALL INCLUDE:

A. General construction/materials/devices per Specification Section 26 29 00 (Manufactured Control Panels).

B. Input/Output modules:

1. Provide new I/O modules on associated controller backplane as required by point lists provided on plans.
2. Discrete inputs & outputs to/from motor starters (or other panels with 120VAC controls/CPTs) shall generally be rated for 120VAC unless noted or required otherwise (to coordinate with typical 120VAC CPTs at motor starters). Discrete inputs & outputs to/from equipment only rated for 24V discrete signals shall be rated for 24V. PLC supplier shall coordinate all I/O voltage rating requirements with associated remote panels/starters/equipment/devices prior to submitting panel shop drawings. Provide isolation relaying/etc. as required to use same voltage classes for discrete inputs and outputs to each piece of equipment such as to allow a common conduit/raceway system to be used .

C. Panel surge protection, lighting, HVAC, auxiliary components, etc. shall be provided per Specification Section 26 29 00.

PART 3 - EXECUTION

3.1 GENERAL

A. SCADA System shall:

1. Measure and monitor discrete and continuous process and process equipment variables (see SCADA Point List on contract plans) per owner's/plant's existing standards.
2. Effectively present the process and process equipment variables to the operators allowing them to accurately monitor the status of the processes. Screens/screen shots shall generally be detailed 2 dimensional (with shaded piping, and project-specific side/elevation views of major processes/tanks/equipment).
3. Provide a means for the operators to effectively control the treatment processes, both automatically and manually.
4. Provide historical data acquisition, storage, retrieval, processing, and report generation.

B. The SCADA software shall be developed to include graphics for the proposed project scope. Human-Machine Interface (HMI) software as specified shall be supplied and fully configured by the System Integrator. Reports, graphics displays, real-time trends, function blocks, PID loop control, historical trends, security, alarming, etc. shall be developed by the System Integrator through a collaborative effort between the Engineer, Owner, Contractor and Equipment Suppliers.

C. The system shall include all provisions as necessary to provide alarm notification to off-site personnel per owner's standards. The system shall be configured to provide customizable alarm information via text-to-voice phone calls, SMS text messages, emails or pagers as

directed/approved by the facility owner. The alarming system shall cascade alarms through a user-editable list of contacts, allowing each user to acknowledge the alarm (and to stop further notifications to other contacts).

D. In general, the operator interface to the system shall be via a hierarchy of graphics screens with "poke points" which will allow operators to navigate the plant facility by facility by simply "clicking" on the poke points with a mouse pointing device. All HMI conventions/graphics shall meet owner's standards/conventions. Integrator shall fully review proposed screen conventions with owner prior to submitting screen submittals.

1. The "Main Menu" shall contain dynamic symbols to depict the operational/communications status of each SCADA System panel/network device on the network (i.e. Normal or In Communications Failure).
2. Each new graphic display shall be designed so that an operator may "click" on "poke points" to gain access to any area of the facility (or to remote systems, where applicable) or to the Main Menu. The operator shall also be able to access the Current Alarms Display from any graphic display. Real-time and Historical Trend displays shall be made available from each plant process area via poke points.
3. All new graphics displays of plant areas shall be based upon detailed 2-D graphics as a basis for the display unless noted otherwise. For example, piping shall generally be drawn as grey-scale 2D pipes with fading (from center of pipe to outside edge of pipe), and with flow direction arrows. Motors, pumps, equipment images, etc. shall include similar detail.
4. Color conventions (for ON, OFF, OPEN, CLOSED, and various levels of alarms) used within the HMI shall be per the owner's standards (to be determined during the construction phase of the project). Consideration should be given to simplifying the color schemes by using bolder colors for alarm conditions than for typical running/off/open/closed conditions.
5. Screen background color (black, grey, white, etc.) shall be as selected by owner. Consideration shall be given to black background color to minimize screen brightness for night operators.
6. Special graphics displays shall be developed by the System Integrator for each process control strategy. These graphics displays shall allow authorized operators to modify control parameters such as set points, operational sequences, etc. Passwords shall be utilized to determine the authorization level of operators.
7. All process alarms shall be categorized by "group" with each group representing a specific area of the plant or distribution system.
8. Security of the system shall be accomplished via allowing access to various parts and features of the system via entry of User names and passwords.
9. Graphics screens shall be developed for each major item of process equipment for which equipment runtime or equipment maintenance data is being collected. These graphics screens shall contain all data relative to the piece of equipment including runtime today, runtime since last serviced, total runtime between maintenance intervals. All runtime data shall be maintained by the various programmable logic controllers; not by the HMI software package.
10. All historical process data, such as average flows, hourly minimums and maximums, etc., shall be maintained by the various programmable logic controllers; not by the HMI software package.

3.2 TESTING

A. General

1. All elements of the hardware and software shall be tested to demonstrate that the total system satisfies all of the requirements of this specification.
2. As a minimum the testing shall include the following:

   a. Operational Readiness Test (ORT)
   b. Functional Acceptance Test (FAT)

3. Each test shall be in the cause and effect format. The person conducting the test shall initiate an input (cause) and upon the system's or subsection's producing the correct result (effect), the specific test requirement will have been satisfied.

B. Operational Readiness Test (ORT)

1. General: Prior to start-up, the entire installed System shall be certified (inspected, tested and documented) that it is ready for operation. These inspections and tests shall include Loop/Component Inspections and Tests and a repeat of the Factory Demonstration Tests.

C. Functional Acceptance Test (FAT)

1. The entire SCADA System shall be tested on-site to demonstrate that it is operational and in conformance with these specifications.
2. Tests shall demonstrate specified functions, both hardware and software, to the satisfaction of the owner.

3.3 TRAINING

A. General

1. Provide an integrated training program for the owner's personnel at the jobsite. Tailor the training program to meet the specific needs of the Owner's personnel. Include training sessions, classroom and field, for managers, engineers, operators and maintenance personnel.
2. The training shall be carried out by technically competent and experienced instructors
3. The Owner shall have the right to make and reuse video tapes of all of the onsite training sessions.
4. One eight (8) hour day shall be provided on site for owner and or engineer selected attendees.

END OF SECTION 27 60 00

SECTION 27 60 05 - INSTRUMENTATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work included: Provide a complete system of instrumentation and controls with appurtenant equipment and accessories as indicated, specified, and as necessary for a complete and proper operating system.

1. Work includes, but not necessarily limited to, the following:

a. All engineering, hardware and software development, installation, startup, ranging, calibration services and supervision necessary.
b. Testing and operational demonstrations as specified.
c. Training programs as specified.
d. Preparation of manuals.

B. Related work:

1. Documents affecting work of this Section include, but are not necessarily limited to, General Specifications, Special Provisions, and all other related Sections.
2. Refer to Specification Section 27 60 00 for additional SCADA System requirements.
3. Refer to plans for point lists and additional device requirements.

1.2 QUALITY ASSURANCE

A. Contractor:

1. Shall be fully and solely responsible for the work of the systems supplier and solely responsible to the Owner for having supplied to the Owner the complete integrated Instrumentation system.
2. To provide personal superintendence and direction of the work, maintaining and supplying complete supervision over and coordination between all subcontractors employed by him and the Instrumentation and Control System Integrator.
3. To be responsible for defining the limits of his subcontractor's work.
4. To be responsible for setting of instruments (including alarms, etc. as provided under other sections).

B. Provide Operation and Maintenance manuals

1. Operating instructions shall incorporate a functional description of the entire system, including the system schematics which reflect “as-built” modifications.
2. Special maintenance requirements particular to the system shall be clearly defined along with special calibration and test procedures.
3. As part of the operation and maintenance manuals, provide one hard copy of the program used to program the programmable logic controller.

1.3 WARRANTY

A. Systems supplier shall furnish a hardware and software warranty for the system starting at substantial completion and ending one year from this date.

1.4 REFERENCES

A. Instrument Society of America (ISA) S5.4, Instrument Loop Diagrams, standard.

B. National Electrical Manufacturers Association (NEMA) Publication, General Standards for Industrial and Control Systems, ICS 1 and Industrial Controls and Systems ICS2.

1.5 SUBMITTALS

A. General/System submittal requirements:

1. Provide submittal (quantity as required by contract) of:

a. Component manufacturing data sheets indicating pertinent data and identifying each component (including all instruments, surge protection devices, antennae, sun/rain shields, etc.) by tag number and nomenclature as indicated on drawings and in specifications.
b. Component drawing showing dimensions, mounting, and external connection details,
c. List of all spare parts. All manufacturers recommended spare parts shall be provided in addition to required spare parts.

2. Identify any specification section where exceptions are being taken or an "or equal" piece of hardware is being proposed.
3. A Bill of Materials shall be included with catalog information on all components.
4. Information shall be included on any proprietary logic component sufficient to demonstrate its ability to perform the required functions.

B. Instrumentation/Field Device submittal requirements:

a. Manufacturer’s product data sheets
b. Job-specific model numbers for each instrument/field device
c. Job-specific ranges/setpoints/etc. proposed for each instrument/field device

1.6 DELIVERY, STORAGE AND HANDLING:

A. Packing and Labeling:

1. Prior to shipment, each component shall be tagged to identify its' location, tag number, and system function. Identification shall be prominently displayed on the outside of the package.

2. Firmly attach permanent stainless-steel, or other durable non corrosive tag to the equipment. Mark tags with the instrument tag number shown in the Instrumentation Data Sheets and/or Instrument drawings.

B. Delivery:

1. Following completion of shop assembly, factory test, and successful submittal of all equipment information (without requirement for resubmittal), equipment shall be shipped. Provide protection for equipment from handling and the environment.

C. Receiving:

1. The contractor is responsible for receiving and proper storage of equipment delivered to the job site.
2. All received items shall be protected from the elements and where required stored in a low humidity environment.
3. Protect materials and equipment against damage in storage and during construction.

PART 2 - INSTRUMENTATION

2.1 GENERAL

A. All equipment and materials shall be new, unused and proved by previous use of similar products to be completely suitable for the service intended.

B. All of the equipment shall be the manufacturer's latest and proven design. Specifications and drawings call attention to certain features but do not purport to cover all details entering into the design of the system. All accessories, hardware, etc. shall be provided as required for a fully functional system. The completed system shall be compatible with the functions required and other equipment furnished by the Contractor.

C. All electrical components of the system shall be powered by 120V, single phase, 60 cycle current or 24VDC loop-powered from control panel, except as otherwise indicated or specified.

D. Cable lengths between sensors/elements and associated transmitters shall be as required by application. Contractor shall coordinate lengths and types of all sensor cables with the associated sensor supplier prior to bid and shall provide cable lengths/types as required.

2.2 LEVEL (OR OPEN CHANNEL FLOW) TRANSMITTERS & ULTRASONIC TRANSDUCERS

A. General:

1. Scope -This section describes the requirements for a 4-wire, multi-functional ultrasonic level/open channel flow transmitter system.
2. Basic System Description

a. The multi-functional level control system (level system) shall employ acoustic echo-ranging technology to determine the distance between the transducer(s) and monitored surface(s), as a basis for display, output, and digital communication.
b. The level/flow monitoring system shall consist of a microprocessor based level transmitter and one or two ultrasonic transducers.
c. The level/flow transmitter shall be operator configurable to meet specific application requirements by implementation of available signal processing and process control functions, in any allowable combination.

B. Technical Specifications:

1. Signal Processing - The level transmitter shall:

a. Employ ultrasonic transceiver(s) suitable for providing excitation to, and processing resultant signals from the attached ultrasonic transducer(s).
b. Create a digitized echo profile, and apply patented Sonic Intelligence echo processing techniques to select and verify the echo representing the reflective surface monitored.
c. Calculate the distance between the transducer face and reflective surface based on the echo selected. The calculated distance may be converted to represent: material level, differential level, average level, space, material volume, vessel ullage, pumped volume, or head, open channel flow rate, and/or total flow volume.
d. Compensate temperature-induced variation in the acoustic wave propagation velocity in air. This compensation shall be based on signals received from the ultrasonic transducer(s) and/or a TS-3 temperature sensor.
e. Include a calibration method and/or enable manual operator value entry, to set a fixed acoustic wave propagation velocity for transmission mediums other than air.
f. Include configuration and calibration ability via integral keypad with non-volatile EEPROM memory to store user-programmed configuration.
g. Display measured variable (level/flow) on the main backlit LCD display along with associated units.

2. Process Control Functions - The level transmitter shall provide an assortment of process control functions that may be user implemented in any allowable combination.

a. Standard Process Control Functions

1) 0/4–20 mA output directly / inversely proportional to level, space, flow or distance
2) Level alarm(s) based on on/off setpoints
3) Loss of Echo or Cable Fault alarm
4) Duty assist pump operation based on fixed or alternating level setpoints
5) Remote relay state control via communications
6) Basic failsafe operation on measurement loss
7) Discrete inputs configurable to override level transmitter I/O operations

3. User Interface - The level transmitter shall enable user access to read only and read/write enabled data, using any of the following methods:

a. Direct or scroll access to data stored in numerical parameters, using the hand programmer and graphic LCD display.
b. IBM PC compatible computer access to data and digital echo profiles, using the Dolphin Plus instrument configuration package.
c. HMI, SCADA, PLC, or DCS system access to data stored in Modbus registers via digital communications.

4. Detailed Specifications:

a. Power

1) 100-230 VAC ± 15%, 50 / 60 Hz, 50VA or less

b. Enclosure

1) Polycarbonate/Polyester, Indoor/Outdoor
2) NEMA 4X / IP 65

c. Ambient Temp.

1) -20 to 50°C (-5 to 122°F)

d. Display

1) Back lit LCD, multi-line display

e. Process Control I/O - The level transmitter shall provide:

1) One (1) 4-20mA HART analog signal output, directly or inversely proportional and scalable to the configured process variables, (dependent upon the transmitter model), capable of driving a 750 ohm load.
2) A minimum of three (3) form C relays with contact outputs based on the level conversion or other process variable as set by the Relay Function and other user configurable relay parameters.
3) Two discrete inputs that may be configured to override normal Process Control Functions.
4) One (1) 4-20mA input (model dependant) that may be scaled to a monitored process variable, to be used as a basis for level transmitter Process Control Functions.

f. Ranges: As directed by Civil Engineer.

5. Accessories:

a. Stainless steel mounting bracket/hardware as recommended by manufacturer.

6. Spare Parts:

a. Provide one (1) spare transducer of each type furnished with manufacturer's cable length to match longest cable length furnished within project.

7. Execution:

a. Maintain minimum separation between transducer and maximum process material level as recommended by manufacturer.
b. Mount transducer to ensure a clear path from the transducer to the process material surface.
c. Where required by the application, provide submergence shield for the transducer(s).

C. Manufacturer/ Model:

1. Pulsar Ultra 5 series transmitter with dB Ultrasonic Level Transducer(s) as required by application.
2. Equal by Siemens Milltronics
3. Equal by Endress + Hauser

2.3 SUN/RAIN SHIELDS

A. General:

1. Sun/Rain Shields shall be:

a. Furnished for all instruments that will be exposed to sun or rain (or where otherwise specifically noted).
b. Furnished by instrumentation supplier.

B. Standard Specifications:

1. Unless specified otherwise, sun/rain shields shall:

a. Have minimum dimensions of 24" wide X 24"high X 6" projection past front of associated instrument. Sun/Rain shields shall be sufficiently sized to accommodate instrument(s) plus associated surge protection device(s), power supplies, and other similar devices.
b. Have top and sides formed of single sheet 10 gauge aluminum.
c. Have back formed of single sheet 10 gauge aluminum tack-welded to top and sides to form a waterproof connection.
d. Have all exposed corners and edges grounded to be smooth and round.

C. Execution:

1. Sun/rain shields shall:

a. Be mounted corrosion resistant stainless steel mounting hardware
b. Include hardware as required to provide a minimum of ¾" separation between instrument (and other similar devices) and back of sun/rain shield.

c. Be mounted to wall, handrail, pipe or other similar supporting structure.

2.4 ELECTRICAL SURGE AND TRANSIENT PROTECTION

A. General

1. Function: Protect the system against damage due to electrical surges.

B. Application: As a minimum, provide surge and transient protection (with proper grounding) at all field instrumentation connected to process piping or where part of circuitry extends outside building(s), as described below:

1. Analog Instruments::

a. Provide surge protection device(s) at power and analog circuit connections to the instrument equipment.
b. At 2-wire, loop-powered instruments, surge protection device shall:

1) Be of stainless steel, pipe-mounted, IP67 construction, nipple-mounted at the instrument as directed by the device supplier.
2) Have 10kA total nominal discharge current per line (based on 8/20µs waveform).
3) Have maximum continuous operating voltage (MCOV) rating as required by the associated signal.
4) Manufacturer and Model:

a) Single 24VDC Signal: Dehn DEHNpipe DP1 CD EXD or equal by Phoenix Contact or Weidmuller
b) Dual 24VDC Signal (or single signal plus separate 24VDC power): Dehn DEHNpipe DP1 CD EXD+D or equal by Phoenix Contact or Weidmuller

c. At 4-wire, separately-powered instruments, surge protection device(s) shall:

1) Have DIN-rail mountable SPD devices within one (1) appropriately-sized NEMA 4X/IP66 fiberglass, polycarbonate or type 316sS enclosure with viewing window (at the field instrument/device).
2) Have 10kA total nominal discharge current per line (based on 8/20µs C2 waveform) for each analog signal.
3) Have 10kA total nominal discharge current per line (based on 8/20µs C2 waveform) for the 120VAC power input.
4) Have quantities of analog signal SPDs as required to match the quantities of analog signal(s) from the associated instrument(s).
5) Have maximum continuous operating voltage (MCOV) rating as required by the associated signal/power circuit(s).
6) Manufacturer and Model: Phoenix Contact BXT-4XP-SEC-T3-120+2X2-24 (or similar with other options as required by application/quantities of signals), or equal by Dehn or Weidmuller

C. Installation and grounding of suppressor: As directed by manufacturer. Provide coordination and inspection of grounding.

PART 3 - EXECUTION

3.1 INTERFACE REQUIREMENTS

A. The instrumentation supplier shall forward submittals clearly identifying all instrumentation interface requirements (inputs/outputs, network connections, register locations for network connections, loop power source requirements, etc.) to the supplier of the associated control and monitoring system, or SCADA system, prior to construction of the associated control and monitoring panels, PLC's, RIO's, RTU's, etc.

3.2 IDENTIFICATION AND LABELING:

A. Refer to Specification Section 26 05 53 for identification and labeling requirements.

3.3 INSTALLATION

A. All equipment shall be installed in accordance with the manufacturer's recommendations.

B. All mounting hardware shall be of corrosion resistant material unless noted otherwise. In exterior or typical process areas, mounting hardware shall be type 316 stainless steel. In extremely corrosive areas (Chlorine rooms, Fluoride rooms, etc.), mounting hardware shall be of non-metallic construction as recommended by the equipment supplier.

3.4 CALIBRATION

A. All instruments provided, relocated or modified within the project shall be calibrated and ranged by a factory-trained representative to the range specified by the process engineer.

B. All calibration procedures shall be implemented using equipment meeting NIST standards.

C. Calibration sheets shall be used to record all applicable calibration settings and calibration equipment data, and to indicate certification of traceability to National Institute of Standards and Technology (NIST) standards.

3.5 TESTING

A. General

1. All elements of the instrumentation system shall be tested to demonstrate that the total system satisfies all of the requirements of this specification.
2. As a minimum the testing shall include the following:

a. Operational Readiness Test (ORT)
b. Functional Acceptance Test (FAT)

3. Each test shall be in the cause and effect format. The person conducting the test shall initiate an input (cause) and upon the system's or subsection's producing the correct result (effect), the specific test requirement will have been satisfied.

B. Operational Readiness Test (ORT)

1. General: Prior to start-up, the entire installed instrumentation system shall be certified (inspected, tested and documented) that it is ready for operation.

C. Functional Acceptance Test (FAT)

1. The entire instrumentation system shall be tested on-site to demonstrate that it is operational and in conformance with these specifications.
2. Tests shall demonstrate specified functions, calibration and ranging to the satisfaction of the owner.

3.6 TRAINING

A. General

1. Provide an integrated training program for the owner's personnel at the jobsite. Tailor the training program to meet the specific needs of the Owner's personnel. Include training sessions, classroom and field, for managers, engineers, operators and maintenance personnel.
2. The training shall be carried out by technically competent and experienced instructors
3. The Owner shall have the right to make and reuse video tapes of all of the onsite training sessions.
4. A minimum of one eight (8) hour day shall be provided on site for training owner and or engineer selected attendees.

3.7 SPARES:

A. A quantity of spare surge protection devices for field instruments equal to 25% of the quantity specified of each type, or one of each type (whichever is greater) shall be provided. For example, a system with surge protection devices for two (2) loop-powered 2-wire field instruments and nine (9) 120V-powered 4-wire field instruments shall be provided with one (1) spare surge protection device for loop-powered 2-wire field instruments and three (3) spare surge protection devices for 120V-powered 4-wire field instruments.

3.8 SYSTEM DOCUMENTATION:

A. Upon completion of the installation, the instrumentation supplier shall provide full documentation sets (quantity as required by other specification sections) to the owner for approval. Documentation shall include:

1. A record set of all information submitted prior to installation.
2. Records of all calibration sheets described above.

3.9 FINAL ACCEPTANCE & SYSTEM CERTIFICATION:

A. Completion of the installation, in-progress and final inspections, receipt of the system documentation, and successful performance of the instrumentation system for a two week period will constitute acceptance of the system.

3.10 WARRANTY:

A. The contractor shall fully warrant the completed instrumentation system to be free from inherent mechanical and electrical defects for a period of one (1) year from the date of final acceptance.

END OF SECTION 27 60 05

SECTION 31 05 16 - AGGREGATES FOR EARTHWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Coarse aggregate materials.
2. Fine aggregate materials.

B. Related Sections:

1. Section 31 20 00 – Earth Moving.

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials:

1. AASHTO M147 - Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base and Surface Courses.
2. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

B. ASTM International:

1. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
2. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3).
3. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3).
4. ASTM D2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).
5. ASTM D4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

C. Alabama Department of Transportation (ALDOT). *Standard Specifications for Highway Construction*, latest edition.

1.3 SUBMITTALS

A. Section 01 33 00 – Submittal Procedures: Requirements for submittals.

B. Materials Source: Submit name of imported materials suppliers.

C. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

A. Furnish each aggregate material from single source throughout the Work.

B. Perform Work according to the Alabama Department of Transportation, Standard Specifications, Construction of Roads and Bridges, latest edition.

C. Maintain one copy of each document on site.

PART 2 - PRODUCTS

2.1 COARSE AGGREGATE MATERIALS

A. Aggregate Designation: No.57

1. Conform to the Alabama Department of Transportation. *Standard Specifications for Highway Construction*, latest edition, Section 800.
2. Percent Passing per Sieve Size:

a.	2 inches:	n/a.
b.	1 1/2 inches:	100.
c.	1 inch:	95 - 100.
d.	3/4 inch:	n/a.
e.	1/2 inch:	25 - 60.
f.	3/8 inches:	n/a.
g.	No. 4:	0 - 10.
h.	No. 8:	0 - 5.
i.	No. 16:	n/a.
j.	No. 100:	n/a.

B. Aggregate: No.67

1. Conform to the Alabama Department of Transportation. *Standard Specifications for Highway Construction*, latest edition, Section 800.
2. Percent Passing per Sieve Size:

a.	2 inches:	n/a.
b.	1 1/2 inches:	n/a.
c.	1 inch:	100.
d.	3/4 inch:	90 - 100
e.	1/2 inch:	n/a.
f.	3/8 inches:	20 - 55.
g.	No. 4:	0 - 10.
h.	No. 8:	0 - 5.
i.	No. 16:	n/a.
j.	No. 100:	n/a.

2.2 FINE AGGREGATE MATERIALS

A. Fine Aggregate:

1. Conform to State of Alabama Highways Standard.
2. Aggregate No.: FA-10M.
3. Percent Passing per Sieve Size:

a.	1/2 inch:	n/a.
b.	3/8 inches:	100.
c.	No. 4:	95 to 100.
d.	No. 8:	84 to 100.
e.	No. 16:	45 to 95.
f.	No. 30:	25 to 75.
g.	No. 50:	8 to 35.
h.	No. 100:	0.5 to 20.
i.	No. 200:	0 to 10*.

*Dust of fracture essentially free from clay or shale, final job site testing only.

2.3 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Testing and inspection services.

B. Coarse Aggregate Material - Testing and Analysis: Perform according to AASHTO T96 or ASTM C131 and AASHTO T11.

C. Fine Aggregate Material - Testing and Analysis: Perform according to ASTM D1557 or AASHTO T180.

D. When tests indicate materials do not meet specified requirements, change material and retest.

PART 3 - EXECUTION

3.1 INSTALLATION OF CRUSHED STONE

A. Crushed stone shall be placed in areas shown on the drawings. Stone shall be consolidated by mechanical means.

B. Unless otherwise specified or shown, crushed stone shall have a minimum thickness of 6”.

C. All crushed stone shall be underlain by an approved geotextile fabric to prevent erosion

3.2 STOCKPILING

A. Stockpile materials on site at locations designated by Architect/Engineer.

B. Stockpile in sufficient quantities to meet Project schedule and requirements.

C. Separate different aggregate materials with dividers or stockpile individually to prevent mixing.

D. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.

E. Stockpile unsuitable materials on impervious material and cover to prevent erosion and leaching, until disposed of.

3.3 STOCKPILE CLEANUP

A. Leave unused materials in neat, compact stockpile.

B. When borrow area is indicated, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

END OF SECTION 31 05 16

SECTION 31 20 00 - EARTH MOVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Excavating and filling for rough grading the Site.
2. Preparing subgrades for process structures and buildings walks and pavements.
3. Excavating and backfilling for buildings and structures.
4. Drainage course for concrete slabs-on-grade.
5. Subbase course for concrete walks and pavements.
6. Subbase course and base course for asphalt paving.
7. Subsurface drainage backfill for walls and trenches.
8. Excavating and backfilling trenches for utilities and pits for buried utility structures.

B. Related Requirements:

1. Section 03 30 00 – Cast-in-Place Concrete for granular course if placed over vapor retarder and beneath the slab-on-grade.

1.2 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Engineer**.** Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices.
2. Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.

3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Engineer. Unauthorized excavation, as well as remedial work directed by Engineer, shall be without additional compensation.

G. Fill: Soil materials used to raise existing grades.

H. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 1 cu. yd. for bulk excavation or 3/4 cu. yd. for footing, trench, and pit excavation that cannot be removed by rock-excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:

1. Equipment for Footing, Trench, and Pit Excavation: Late-model, track-mounted hydraulic excavator; equipped with a 42-inch (1065-mm-) maximum-width, short-tip-radius rock bucket; rated at not less than 138-hp flywheel power with bucket-curling force of not less than 28,700 lbf and stick-crowd force of not less than 18,400 lbf with extra-long reach boom.
2. Equipment for Bulk Excavation: Late-model, track-mounted loader; rated at not less than 230-hp flywheel power and developing a minimum of 47,992-lbf breakout force with a general-purpose bare bucket.
3. Blasting may be required for foundation preparation.

I. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material 3/4 cu. yd**.** or more in volume that exceed a standard penetration resistance of 100 blows/2 inches when tested by a geotechnical testing agency, according to ASTM D 1586.

J. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

K. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

L. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

M. Utilities: On-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference:

1. Review methods and procedures related to earthmoving, including, but not limited to, the following:

a. Personnel and equipment needed to make progress and avoid delays.
b. Coordination of Work with utility locator service.

c. Coordination of Work and equipment movement with the locations of tree- and plant-protection zones.
d. Extent of trenching by hand or with air spade.
e. Field quality control.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of the following manufactured products required:

1. Geotextiles.
2. Controlled low-strength material, including design mixture.
3. Geofoam.
4. Warning tapes.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Material Test Reports: For each on-site and off-site soil material proposed for fill and backfill as follows:

1. Classification according to ASTM D 2487.
2. Laboratory compaction curve according to ASTM D 698.

C. Pre-excavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earth-moving operations. Submit before earth moving begins.

1.6 QUALITY ASSURANCE

A. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E 329 and ASTM D 3740 for testing indicated.

1.7 FIELD CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth-moving operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Improvements on Adjoining Property: Authority for performing earth moving indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.

1. Do not proceed with work on adjoining property until directed by Engineer.

C. Utility Locator Service: Notify "Call Before You Dig" for area where Project is located before beginning earth-moving operations.

D. Do not commence earth-moving operations until temporary site fencing and erosion- and sedimentation-control measures specified in Section 31 10 00 – Site Clearing are in place.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, and SM according to ASTM D 2487, or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 294 0; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve.

F. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.

H. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and zero to 5 percent passing a No. 8 sieve.

I. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and zero to 5 percent passing a No. 4 sieve.

J. Sand: ASTM C 33; fine aggregate.

K. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 GEOTEXTILES

A. Subsurface Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability: Class 2; AASHTO M 288.
2. Survivability: As follows:

    a. Grab Tensile Strength: 157 lbf ; ASTM D 4632.
    b. Sewn Seam Strength: 142 lbf ; ASTM D 4632.
    c. Tear Strength: 56 lbf ; ASTM D 4533.
    d. Puncture Strength: 56 lbf ; ASTM D 4833.

3. Apparent Opening Size: No. 40, No. 60 sieve, maximum; ASTM D 4751.
4. Permittivity: 0.1 per second, minimum; ASTM D 4491.
5. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

B. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability: Class 2; AASHTO M 288.
2. Survivability: As follows:

    a. Grab Tensile Strength: 247 lbf ; ASTM D 4632.
    b. Sewn Seam Strength: 222 lbf ; ASTM D 4632.
    c. Tear Strength: 90 lbf ; ASTM D 4533.
    d. Puncture Strength: 90 lbf ; ASTM D 4833.

3. Apparent Opening Size: No. 60 sieve, maximum; ASTM D 4751.
4. Permittivity: 0.02 per second, minimum; ASTM D 4491.
5. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

2.3 CONTROLLED LOW-STRENGTH MATERIAL

A. Controlled Low-Strength Material: Self-compacting**,** low-density, flowable concrete material produced from the following:

1. Portland Cement: ASTM C 150, Type I.
2. Fly Ash: ASTM C 618, Class C or F.
3. Normal-Weight Aggregate: ASTM C 33, 3/4-inch, or 3/8-inch nominal maximum aggregate size.
4. Foaming Agent: ASTM C 869.
5. Water: ASTM C 94.
6. Air-Entraining Admixture: ASTM C 260.

B. Produce low-density, controlled low-strength material with the following physical properties:

1. As-Cast Unit Weight: 30 to 36 lb/cu. ft., or 36 to 42 lb/cu. ft. at point of placement, when tested according to ASTM C 138.
2. Compressive Strength: 80 psi, or 140 psi, when tested according to ASTM C 495.

C. Produce conventional-weight, controlled low-strength material with 80-psi 140-psi compressive strength when tested according to ASTM C 495.

2.4 ACCESSORIES

A. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

B. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth-moving operations.

B. Protect and maintain erosion and sedimentation controls during earth-moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

3.3 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
2. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:

a. 24 inches outside of concrete forms other than at footings.
b. 12 inches outside of concrete forms at footings.
c. 6 inches outside of minimum required dimensions of concrete cast against grade.
d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
e. 6 inches beneath bottom of concrete slabs-on-grade.
f. 6 inches beneath pipe in trenches and the greater of 24 inches wider than pipe or 42inches.

B. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock. Do not excavate rock until it has been classified and cross sectioned by Engineer. The Contract Sum will be adjusted for rock excavation according to unit prices included in the Contract Documents. Changes in the Contract Time may be authorized for rock excavation.

1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; and soil, boulders, and other materials not classified as rock or unauthorized excavation.

a. Intermittent drilling; blasting, if permitted; ram hammering; or ripping of material not classified as rock excavation is earth excavation.

2. Rock excavation includes removal and disposal of rock. Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction without exceeding the following dimensions:

a. 24 inches outside of concrete forms other than at footings.
b. 12 inches outside of concrete forms at footings.
c. 6 inches outside of minimum required dimensions of concrete cast against grade.
d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.

e. 6 inches beneath bottom of concrete slabs-on-grade.
f. 6 inches beneath pipe in trenches and the greater of 24 inches wider than pipe or 42 inches wide.

3.4 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
2. Pile Foundations: Stop excavations 6 to 12 inches above bottom of pile cap before piles are placed. After piles have been driven, remove loose and displaced material. Excavate to final grade, leaving solid base to receive concrete pile caps.
3. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces.

B. Excavations at Edges of Tree- and Plant-Protection Zones:

1. Excavate by hand or with an air spade to indicated lines, cross sections, elevations, and subgrades. If excavating by hand, use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.

3.5 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.6 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to minimum 12 inches higher than top of pipe or conduit unless otherwise indicated.

1. Clearance: 12 inches each side of pipe or conduit.

C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

1. For pipes and conduit less than 6 inches in nominal diameter, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
2. For pipes and conduit 6 inches or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe or conduit circumference. Fill depressions with tamped sand backfill.
3. For flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support conduit on an undisturbed subgrade.
4. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

D. Trench Bottoms: Excavate trenches 4 inches deeper than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe.

1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

E. Trenches in Tree- and Plant-Protection Zones:

1. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.

3.7 SUBGRADE INSPECTION

A. Notify Engineer when excavations have reached required subgrade.

B. If Engineer determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

C. Proof-roll subgrade below the building slabs, plant structures and pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Engineer, and replace with compacted backfill or fill as directed.

D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices.

E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Engineer, without additional compensation.

3.8 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by Engineer.

1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Engineer.

3.9 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.10 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for Record Documents.
3. Testing and inspecting underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring, bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.11 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Trenches under Footings: Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Section 03 30 00 – Cast-in-Place Concrete.

D. Trenches under Roadways: Provide 4-inch thick, concrete-base slab support for piping or conduit less than 30 inches below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches of concrete before backfilling or placing roadway subbase course. Concrete is specified in Section 03 30 00 - Cast-in-Place Concrete.

E. Backfill voids with satisfactory soil while removing shoring and bracing.

F. Initial Backfill:

1. Soil Backfill: Place and compact initial backfill of satisfactory soil, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.

    a. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

2. Controlled Low-Strength Material: Place initial backfill of controlled low-strength material to a height of 12 inches over the pipe or conduit. Coordinate backfilling with utilities testing.

G. Final Backfill:

1. Soil Backfill: Place and compact final backfill of satisfactory soil to final subgrade elevation.
2. Controlled Low-Strength Material: Place final backfill of controlled low-strength material to final subgrade elevation.

H. Warning Tape: Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.12 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:

1. Under grass and planted areas, use satisfactory soil material.
2. Under walks and pavements, use satisfactory soil material.
3. Under steps and ramps, use engineered fill.
4. Under building slabs, use engineered fill.
5. Under footings and foundations, use engineered fill.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.13 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.14 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698:

1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.
2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 95 percent.
3. Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 92 percent.
4. For utility trenches, compact each layer of initial and final backfill soil material at 95 percent.

3.15 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to elevations required to achieve indicated finish elevations, within the following subgrade tolerances:

1. Turf or Unpaved Areas: Plus or minus 1 inch.
2. Walks: Plus or minus 1/2 inch.
3. Pavements: Plus or minus 1/2 inch.

C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.16 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

A. Place subbase course and base course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place subbase course and base course under pavements and walks as follows:

1. Install separation geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.

2. Place base course material over subbase course under hot-mix asphalt pavement.
3. Shape subbase course and base course to required crown elevations and cross-slope grades.
4. Place subbase course and base course 6 inches or less in compacted thickness in a single layer.
5. Place subbase course and base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
6. Compact subbase course and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

C. Pavement Shoulders: Place shoulders along edges of subbase course and base course to prevent lateral movement. Construct shoulders, at least 12 inches wide, of satisfactory soil materials and compact simultaneously with each subbase and base layer to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.17 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

A. Place drainage course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:

1. Install subdrainage geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
2. Place drainage course 6 inches or less in compacted thickness in a single layer.
3. Place drainage course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
4. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.18 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:

1. Determine prior to placement of fill that site has been prepared in compliance with requirements.
2. Determine that fill material classification and maximum lift thickness comply with requirements.
3. Determine, during placement and compaction that in-place density of compacted fill complies with requirements.

B. Testing Agency: Contractor will engage a qualified geotechnical engineering testing agency to perform tests and inspections.

C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

D. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Engineer.

E. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2937, and ASTM D 6938, as applicable. Tests will be performed at the following locations and frequencies:

1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. or less of paved area or building slab but in no case fewer than three tests.
2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet or less of wall length but no fewer than two tests.
3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length but no fewer than two tests.

F. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.19 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by Engineer; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.20 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

B. Transport surplus satisfactory soil to designated storage areas on Owner's property. Stockpile or spread soil as directed by Engineer.

1. Remove waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 31 20 00

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 40 05 06 - COUPLINGS, ADAPTERS, AND SPECIALS FOR PROCESS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe penetrations.
2. Restrained joints.
3. Braided flexible connections.
4. Expansion joints.
5. Expansion loops.
6. Sleeve-type couplings.
7. Wall sleeves.

B. Related Requirements:

1. Section 05 50 00 - Metal Fabrications
2. Section 09 96 00 – High-Performance Coatings
3. Division 40 – Process Interconnections

C. Conform to the requirements of Section 40 05 13 – Common Requirements for Process Piping

1.2 REFERENCE STANDARDS

A. American Water Works Association:

1. AWWA C219 - Bolted, Sleeve-Type Couplings for Plain-End Pipe.
2. AWWA C227 Bolted, Split-Sleeve Restrained and Nonrestrained Couplings for Plain-End Pipe.

B. American Welding Society:

1. AWS D1.1 - Structural Welding Code - Steel.

C. ASME International:

1. ASME A13.1 - Scheme for the Identification of Piping Systems.
2. ASME B31.3 - Process Piping.
3. ASME B31.9 - Building Services Piping.
4. ASME Boiler and Pressure Vessel Code (BPVC), Section IX - Welding, Brazing, and Fusing Qualifications.

D. ASTM International:

1. ASTM D2000 - Standard Classification System for Rubber Products in Automotive Applications.

2. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
3. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
4. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems.
5. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.

E. Expansion Joint Manufacturers Association, Inc.:

1. EJMA Standards.

F. NSF International:

1. NSF 61 - Drinking Water System Components - Health Effects.
2. NSF 372 - Drinking Water System Components - Lead Content.

G. UL:

1. UL 263 - Fire Tests of Building Construction and Materials.
2. UL 1479 - Fire Tests of Through-Penetration Firestops.
3. UL 2079 - Tests for Fire Resistance of Building Joint Systems.

PART 2 - PRODUCTS

2.1 PIPE PENETRATIONS

A. Flashing:

1. Metal Flashing:

a. Material: 304 stainless steel.
b. Thickness: 26 gage.

2. Metal Counterflashing:

a. Material: 304 stainless steel.
b. Thickness: 22 gage.

3. Flexible Flashing Materials:

a. Material: Butyl sheet, PVC sheet, or Compatible with service conditions.
b. Thickness: 47 mils.

4. Caps:

a. Material: 304 stainless steel.
b. Minimum Thickness: 22 gage, and 16 gage at fire-resistive elements.

B. Sleeves:

1. Sleeves for Pipes through Non-fire-rated Floors:

    a. Material: 304 stainless steel.
    b. Thickness: 0.0625 inch minimum

2. Sealant:

    a. As specified in Section 07 92 00 - Joint Sealants.

C. Mechanical Sleeve Seals:

1. Manufacturers:

    a. Flexicraft Industries, PipeSeal
    b. GPT (Link-Seal)
    c. Or Approval Equal

2. Description:

    a. Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve.
    b. Connection: Bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.2 RESTRAINED JOINTS

A. Flange Adapter (Set Screws)

1. Manufacturer:

    a. EZ Flange Adapter (EBAA Iron, Inc.)
    b. Uni-Flange, series 400 (0R series 420)
    c. Ford Meter Box Company, Inc. (Nappco, Inc.)
    d. Star Pipe Series 400
    e. Or Approved Equal.

2. Description:

    a. The uniflange assembly shall be used only in instances shown on the drawings. If the Contractor proposes to use uniflanges at other locations, he shall first obtain approval from the Engineer.
    b. The uniflange shall consist of a Ductile Iron ASTM A536 Grade 65-45-12 flange with ANSI B16.1 Class 125 & 250 or ANSI B16.5 Class 150 & 300 drillings.
    c. The standard gasket of Buna S for water and wastewater shall be supplied.
    d. The uniflange class shall be suitable for the pressure service. (2”-12” = 250 psi, 14”-24” = 150psi, >24” = 100 psi)

B. Flange Adapter-Restrained

1. Manufacturer:

a. SERIES 2100 MEGAFLANGE adapter, as produced by EBAA Iron, Inc.,
b. StarFlange Series 3200
c. Or Approved Equal.

2. Description:

a. Restrained flange adapters may be used in lieu of threaded, or welded, flanged spool pieces. Flange adapters shall be made of ductile iron conforming to ASTM A536 and have flange bolt circles that are compatible with ANSI/AWWA C110/A21.10.
b. Restraint for the flange adapter shall consist of a plurality of individual actuated gripping wedges to maximize restraint capability. Torque limiting actuating screws shall be used to insure proper initial set of gripping wedges.
c. The flange adapter shall be capable of deflection during assembly, or permit lengths of pipe to be field cut, to allow a minimum of 0.6" gap between the end of the pipe and the mating flange without affecting the integrity of the seal.
d. Flange Adapters shall be fully restrained and shall incorporate a wedge style grip.
e. Allowable working pressures shall have a minimum as follows: 3"-16" = 350 psi, 18"-24" = 250 psi, 30"-48" = 150 psi.

C. Adapter with Wedge Restraints for Mechanical Joint pipe.

1. Manufacturer:

a. Uni-Flange Series 1400, by Ford Meter Box Company
b. StarGrip 3000 by Star Pipe Products
c. Megalug Series 1100 by EBBA Iron Sales, Inc.
d. Or Approved Equal.

2. Description:

a. Restraint for standardized mechanical joints shall be incorporated into the design of the follower gland and shall impart multiple points of wedge action against the pipe, increasing its resistance as the pressure increases.
b. The restrained joint shall incorporate a wedge style restraint system. Restraints with set screws will not be acceptable.
c. The assembled joint shall maintain its flexibility after burial and shall maintain its integrity by a controlled and limited expansion of each joint during the wedging action.
d. Restraining glands shall be manufactured of high strength ductile iron conforming to the requirements of ASTM A536, Grade 65-45-12.
e. Wedges shall be contoured to properly fit on the pipe, and shall be manufactured of ductile iron, heat treated to a minimum hardness of 370 BHN. Dimensions of the glands shall be such that they can be used with the standardized mechanical joint bell and tee head bolts conforming to the requirements of ANSI/AWWA C111/A21.11 and ANSI/AWWA C153/A21.53 of latest revision.
f. Twist-off heads shall be incorporated in the design of the wedge actuating screws to ensure proper torque.
g. The mechanical joint restraining device shall have a water working pressure rating of 250 psi minimum with a safety factor of at least 2:1 against separation when tested in a dead-end situation

h. Allowable working pressures shall be as follows: 3”-16” = 350 psi, 18”-36” = 250psi.

2.3 BRAIDED FLEXIBLE CONNECTIONS

A. Manufacturers:

1. Flexicraft Industries
2. Flex-Weld, Inc.
3. Hyspan Precision Products, Inc.
4. Or Approved Equal.

B. Steel or Stainless Steel Piping:

1. Inner Hose: Corrugated stainless steel as indicated.
2. Exterior Sleeve: Braided or stainless steel as indicated.
3. Pressure Rating: Minimum 150 psig at 50 ºF and sufficient for service condition.
4. Fittings: Flanged, unless otherwise noted.
5. Size: Use pipe-sized units.
6. Maximum Offset: 3/4inch on each side of installed center line.

C. Copper Piping:

1. Inner Hose: Corrugated Bronze.
2. Exterior Sleeve: Braided bronze.
3. Pressure Rating: Minimum 150 psig at 70 ºF and sufficient for service condition.
4. Fittings: Threaded with union, Soldered, or as specified for pipe joints.
5. Size: Use pipe-sized units.
6. Maximum Offset: 3/4 inch on each side of installed center line.

2.4 EXPANSION JOINTS

A. Manufacturers:

1. Flexicraft Industries
2. Flex-Weld, Inc.
3. Hyspan Precision Products, Inc.
4. Or Approved Equal

B. Performance and Design Criteria:

1. Bellow Design: According to Section C of EJMA Standards.

C. Stainless-Steel Compensator Type:

1. Pressure Rating: 50 psig WOG at 250 ºF for aeration air piping, all others shall be 200 psig WOG at 250 ºF.
2. Maximum Compression: 1-3/4 inches.
3. Maximum Extension: 1/4 inch.

4. Joint: Flanged, unless otherwise noted.
5. Size: Use pipe-sized units.
6. Application: Aeration air piping 4-inch and larger or steel piping 3 inches and smaller.

D. External Ring-Controlled Stainless-Steel Bellows Type:

1. Pressure Rating: 200 psig WOG at 250 ºF.
2. Maximum Compression: 1-1/4 inches.
3. Maximum Extension: 3/8 inch.
4. Maximum Offset: 5/16 inch.
5. Joint: Flanged.
6. Size: Use pipe-sized units.
7. Accessories: Internal flow liner.
8. Application: Steel piping 3 inches and larger.

E. Single-Arch Rubber Type:

1. Body: Neoprene with nylon fabric reinforcement.
2. Working Pressure: 150 psig.
3. Maximum Temperature: 200 ºF.
4. Maximum Compression: 1 inch.
5. Maximum Elongation: 5/8 inch.
6. Maximum Offset: 1/2 inch.
7. Maximum Angular Movement: 30 degrees.
8. Joint: 304 stainless steel tapped backing rings.
9. Size: Use pipe-sized units.
10. Accessories: Control rods.
11. Application: Steel piping 2 inches and larger.

F. Bronze Compensator Type:

1. Description: Bronze with anti-torque device, limit stops, and internal guides.
2. Pressure Rating: 200 psig WOG at 250 ºF.
3. Maximum Compression: 3 inches.
4. Maximum Extension: 1/4 inch.
5. Size: Use pipe-sized units.
6. Application: Copper piping.

2.5 EXPANSION LOOPS

A. Provide expansion loops as indicated on Shop Drawings.

2.6 SLEEVE-TYPE COUPLINGS

A. Manufacturers:

1. Dresser Piping Specialties
2. The Macomb Group
3. US Pipe Fabrication

B. Description:

1. Comply with AWWA C219.
2. Middle Ring: Epoxy Coated Steel.
3. Followers: Epoxy Coated Steel.
4. Gaskets:

    a. Material: Buna-N, EPDM, or Compatible with service conditions.
    b. Comply with ASTM D2000.

5. Bolts: AWWA C111, Epoxy Coated Steel.

2.7 WALL SLEEVE

A. Manufacturers:

1. Sigma – Omni-Sleeve.
2. American
3. Or Approved Equal.

B. Description:

1. Wall and floor pipe penetrations of ductile iron piping systems shall be made by means of a sleeve capable of being bolted directly to the formwork to prevent misalignment. Seal of annular space shall be by means of a confined rubber gasket, so as not to be affected by vibration and capable of withstanding up to 100 psig. Sleeve shall be manufactured from Ductile Iron with an integrally cast water stop.

2.8 FINISHES

A. Prepare ferrous metal piping appurtenances for field finishes as specified in Section 09 96 00 – High-Performance Coatings.

2.9 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.

1. Provide shop inspection and testing of completed assemblies.

B. Certificate of Compliance:

1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
2. Specified shop tests are not required for Work performed by approved manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that field dimensions are as indicated on Shop Drawings.

C. Inspect existing flanges for nonstandard bolthole configurations or design and verify that new pipe and flanges mate properly.

D. Verify that openings are ready to receive sleeves.

E. Verify that pipe plain ends to receive sleeve-type couplings or flange adapters are smooth and round for 12 inches from pipe ends.

F. Verify that pipe outside diameter conforms to sleeve manufacturer's requirements.

3.2 PREPARATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.

B. Cleaning: Thoroughly clean end connections before installation.

C. Close pipe and equipment openings with caps or plugs during installation.

D. Surface Preparation: Clean surfaces to remove foreign substances.

3.3 INSTALLATION

A. According to ASME B31.3 for process piping and ASME B31.9 for building services piping.

B. Coating: Finish ferrous metal piping appurtenances as specified in Section 09 96 00 – High-Performance Coatings for service conditions.

C. Pipe Penetrations:

1. Flashing:

a. Provide flexible flashing and metal counterflashing where piping penetrates weatherproofed or waterproofed walls, floors, and roofs.
b. Flash floor drains with topping over finished areas with lead, 10 inches clear on sides, with minimum 36-by-36-inch sheet size.
c. Fasten flashing to drain clamp device.

2. Sleeves:

a. Exterior Watertight Entries: Seal with mechanical sleeve seals.
b. Set sleeves in position in forms and provide reinforcement around sleeves.
c. Size sleeves large enough to allow for movement due to expansion and contraction and provide for continuous insulation wrapping.
d. Extend sleeves through floors 1/2 inches above finished floor level and calk sleeves.
e. Where piping penetrates floor, ceiling, or wall, close off space between pipe and adjacent Work with insulation and calk airtight.
f. Provide close-fitting metal collar or escutcheon covers at both sides of penetration.
g. Install stainless-steel escutcheons at finished surfaces.

D. Firestopping:

1. Placement: Place intumescent coating in sufficient coats to achieve rating required.
2. Fire-Rated Surfaces:

a. Seal opening at floor, wall, partition, ceiling and roof.
b. Install sleeve through opening and extend beyond minimum of 1 inch on both sides of building element.
c. Size sleeve, allowing minimum of 1 inch void between sleeve and building element.
d. Pack void with backing material.
e. Seal ends of sleeve with UL-listed, fire-resistive silicone compound to meet fire rating of structure penetrated.

3. Non-rated Surfaces:

a. Seal opening through non-fire-rated floor, wall, partition, ceiling and roof.
b. Install sleeve through opening and extend beyond minimum of 1 inch on both sides of building element.
c. Size sleeve to allow minimum of 1 inch void between sleeve and building element.
d. Install type of firestopping material recommended by manufacturer.
e. Occupied Spaces:

1) Install escutcheons, floor plates, or ceiling plates where conduit penetrates non-fire-rated surfaces in occupied spaces.
2) Occupied spaces include rooms with finished ceilings and rooms where penetration occurs below finished ceiling.

f. Exterior Wall Openings below Grade: Assemble rubber links of mechanical sealing device to size of piping and tighten in place according to manufacturer instructions.
g. Interior Partitions:

1) Seal pipe penetrations at where indicated.
2) Apply sealant to both sides of penetration to completely fill annular space between sleeve and conduit.

E. Flexible Connections: Install flexible couplings at connections to equipment and where indicated on Shop Drawings.

F. Expansion Joints:

1. Install flexible couplings and expansion joints at connections to equipment and where indicated on Drawings.
2. If expansion joint is supplied with internal sleeve, indicate flow direction on outside of joint.

G. Air Release and Vacuum Breakers: Provide vacuum breakers on all tanks and process equipment.

H. Backflow Preventers:

1. Install with nameplate and test cock accessible.
2. Install according to local code requirements.
3. Do not install in vertical position.

3.4 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.

B. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

C. After installation, inspect for proper supports and interferences.

D. Repair damaged coatings with material equal to original coating.

3.5 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.

B. Keep equipment interior clean as installation progresses.

END OF SECTION 40 05 06

SECTION 40 05 07 - HANGERS AND SUPPORTS FOR PROCESS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe hangers and supports.
2. Hanger rods.
3. Structural attachments.
4. Pipe guides.
5. Guides
6. Anchors
7. Elbow and Flange Supports
8. Concrete Duct Spacers
9. Carrier Pipe Spacers Within Carrier Pipe

B. Related Requirements:

1. Section 03 30 00 - Cast-in-Place Concrete
2. Division 05 – Metals
3. Section 07 92 00 – Joint Sealants
4. Section 09 96 00 – High-Performance Coatings
5. Section 26 05 43 – Underground Ducts and Raceways for Electrical Systems
6. Division 40 – Process Interconnections

1.2 REFERENCE STANDARDS

A. American Society of Mechanical Engineers:

1. ASME B31.1 - Power Piping.
2. ASME B31.9 - Building Services Piping.

B. ASTM International:

1. ASTM A36 - Standard Specification for Carbon Structural Steel.
2. ASTM A47 - Standard Specification for Ferritic Malleable Iron Castings.
3. ASTM A576 - Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality.
4. ASTM A181 - Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.
5. ASTM F512 – Standard Specification for Smooth-Wall PVC

C. National Electrical Manufacturers Association

1. NEMA TC-2 – Electrical Polyvinyl Chloride (PVC) Conduit

2. NEMA TC-6 & 8 – Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installations
3. NEMA TC-10 – Polyvinyl Chloride (PVC) Plastic Communications Duct and Fittings for Underground Installation

D. American Welding Society:

1. AWS D1.1 - Structural Welding Code Steel - Reference Manual.

E. Manufacturers Standardization Society of the Valve and Fittings Industry:

1. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacturer, Selection, Application, and Installation.

1.3 COORDINATION

A. Section 01 31 00 – Project Management and Coordination

B. Coordinate Work of this Section with piping and equipment connections specified in other Sections and indicated on Drawings.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer's catalog data including load capacity.

C. Shop Drawings: Indicate system layout with location - including critical dimensions, sizes, and pipe hanger and support locations - and detail of trapeze hangers, anchors, and guides.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Welders' Certificate: Submit welders' certification of compliance with ASME Section IX or AWS D1.1, verifying qualification within previous 12 months.

F. Delegated Design Submittals:

1. Submit signed and sealed Shop Drawings with design calculations and assumptions for load carrying capacity of trapeze, multiple pipe, and riser support hangers.
2. Indicate calculations used to determine load carrying capacity of trapeze, multiple pipe, and riser support hangers.
3. Submit sizing methods or calculations sealed by a registered professional engineer.

G. Manufacturers' Instructions: Submit special procedures and assembly of components.

H. Qualifications Statements:

1. Submit qualifications for manufacturer, fabricator, installer, and licensed professional.
2. Submit manufacturer's approval of installer.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance materials.

B. Spare Parts:

1. Furnish one set of manufacturer's recommended spare parts.

1.6 QUALITY ASSURANCE

A. Perform Work according to applicable authority and/or AWS D1.1 for welding hanger and support attachments to building structure.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this Section with minimum five (5) years' documented experience.

B. Fabricator: Company specializing in fabricating products specified in this Section with minimum five (5) years' documented experience.

C. Installer: Company specializing in performing Work of this Section with minimum five (5) years' documented experience and approved by manufacturer.

D. Licensed Professional: Professional engineer experienced in design of specified Work and licensed in State in which the project is located.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on-Site in original factory packaging, labeled with manufacturer's identification.

C. Protect products from weather and construction traffic, dirt, water, chemical, and damage by storing in original packaging.

1.9 AMBIENT CONDITIONS

A. Section 01 50 00 - Temporary Facilities and Controls

B. Provide ventilation in areas receiving solvent-cured materials.

1.10 EXISTING CONDITIONS

A. Field Measurements: Verify field measurements prior to fabrication. Indicate field measurements on Shop Drawings.

1.11 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. Furnish five-year manufacturer's warranty for pipe hangers and supports.

PART 2 - PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

A. Description:

1. Horizontal Piping Hangers and Supports

a. General: Except as otherwise indicated, provide factory-fabricated horizontal piping hangers and supports of MSS type and size indicated, bolts (if any) and washers; comply with MSS SP-58 and manufacturer's published product information. Where MSS type or size is not indicated, provide proper selection as determined by Installer for installation requirements, and comply with MSS SP-69 and manufacturer's published product information; size hangers and supports properly for piping including insulation (if any). Provide copper-plated hangers and supports for uninsulated copper-piping systems. Provide 304 stainless steel supports and hangers for stainless steel piping systems.

2. Vertical Piping Clamps

a. General: Except as otherwise indicated, provide factory-fabricated vertical piping clamps of MSS type and size indicated; comply with MSS SP-58 and manufacturer's published product information. Where MSS type or size is not indicated, provide proper selection as determined by Installer for installation requirements, and comply with MSS SP-69 and manufacturer's published product information. Size clamps properly for piping, including insulation (if any). Provide copper-plated clamps for copper-piping systems. Provide 304 stainless steel supports and hangers for stainless steel piping systems.

3. Hanger Rod Attachments

a. General: Except as otherwise indicated, provide factory-fabricated hanger-rod attachments of MSS type and size indicated; comply with MSS SP-58 and manufacturer's published product information. Where MSS type or size is not indicated, provide proper selection determined by Installer for installation requirements, and comply with MSS SP-69 and manufacturer's published product information. Size attachments properly for piping, including insulation (if any).

Provide copper-plated hanger-rod attachments for uninsulated copper-piping systems. Provide 304 stainless steel supports and hangers for stainless steel piping systems.

4. Structural Attachments

   a. General: Except as otherwise indicated, provide factory-fabricated building attachments of MSS type and load-rating indicated; comply with MSS SP-58 and manufacturer's published product information. Where MSS type or load-rating is not indicated, provide proper selection determined by Installer for installation requirements, and comply with MSS SP-69 and manufacturer's published product information. Size units properly for the piping loading.

B. Performance and Design Criteria:

1. General

   a. Design, size and locate piping support systems throughout facility, whether shown or not.
   b. Piping smaller than 30 inches: Supports are shown only where specific types and locations are required; additional pipe supports may be required.
   c. Piping 30 inches and Larger: N/A
   d. Meet requirements of MSS SP 58 and ASME B31.1 or as modified by this Section.

2. Pipe Support Systems

   a. Design pipe support systems for gravity and thrust loads imposed by weight of pipes or internal pressures, including insulation and weight of fluid in pipes.
   b. Maximum Support Spacing and Minimum Rod Size: In accordance MSS SP 58 Table 3 and Table 4.

3. Anchoring Devices: Design, size and space support anchoring devices, including anchor bolts, inserts, and other devices used to anchor support, to withstand shear and pullout loads imposed by loading and spacing on each particular support.
4. Vertical Sway Bracing: 10-foot maximum centers or as shown.
5. Existing Support Systems: Use existing supports systems to support new piping only if Contractor can show they are adequate for additional load, or if they are strengthened to support additional load. Allow for expansion and contraction of piping while eliminating undue stress on piping appurtenances and equipment.
6. Provide linkage to permit lateral or axial movement where anticipated.
7. Where horizontal pipe movement is greater than ½ inch, or where hanger rod deflection from the vertical is greater than 4 degrees from cold to hot position of pipe, hanger rod and structural attachment shall be offset to maintain rod vertical in hot position.
8. Heat Transmission: Design supports, hangers, anchors, and guides to prevent excessive heat from being transmitted to building structure, equipment, or piping appurtenances.
9. Riser Supports: Support risers on each floor with riser clamps and lugs, independent of connected horizontal piping.
10. Point Loads:

    a. Support plastic piping containing meters, valves, appurtenances, and other point loads on both sides.

b. Avoid point loads on plastic piping by providing extra wide pipe saddles or galvanized steel shields.

2.2 HANGERS

A. Clevis: MSS SP 58, Type 1

1. Shall be used for the suspension of non-insulated pipe or insulated with B3151 shield or Anvil ISS

a. Shall be used for the suspension of non-insulated pipe or insulated with B3151 shield or Anvil ISS

1) B-Line; Figure B3100, 1/2 inch to 30 inches
2) Anvil: Figure 260 for steel pipe and Figure 590, 1/2 inch to 30 inches
3) Insulated Steel Pipe; B-Line; Figure B3100 with B3151 shield, ½ inch through 16 inches
4) Insulated Steel Pipe; Anvil; Figure 260 with insulated saddle system (ISS), ½ inch through 12 inches
5) Or Approved Equal

b. Adjustable Swivel Split-Ring Pipe Clamp: MSS SP 58, Type 6

a. Shall be used for suspension of non-insulated stationary pipe

1) B-Line; Figure B3171, : ¾ inch through 8 inches
2) Anvil; Figure 104, : ¾ inch through 8 inches
3) Or Approved Equal

c. Steel Yoke Pipe Rolls and Roller Supports: MSS SP 58, Type 41 or Type 43

a. Shall be used to support pipe where movement may occur due to thermal expansion

1) B-Line; Figure B3110 for sizes 2 inches through 24 inches and Figure B3114 for 30 inches.
2) Anvil; Figure 181 for sizes 2-1/2 inches through 24 inches and Figure 171 for sizes 1 inch through 30 inches
3) Or Approved Equal

d. Pipe Rollers and Supports: MSS SP 58, Type 44

a. Shall be used to support pipe where movement may occur due to thermal expansion when ceiling suspension is impractical

1) B-Line; Figure B3120, sizes 2 inches through 24 inches
2) Anvil; Figure 175, sizes 2 inches through 30 inches
3) Or Approved Equal

2.2 HANGER RODS

A. Hanger Rods:

1. ASTM A576, steel.
2. Threaded both ends or Threaded one end or All-thread.
3. Diameter: ASME B31.1; as indicated on Drawings.

2.3 STRUCTURAL ATTACHMENTS

A. Welded Steel Wall Bracket: MSS SP 58, Type 33 (heavy duty)

1. Anvil; Figure 199, 3,000-pound rating.
2. B-Line; Figure B3067, 3,000-pound rating.
3. Or Approved Equal

B. Adjustable "J" hanger MSS SP 58, Type 5:

1. Anvil; Figure 67, sizes ½ inch through 8 inches.
2. B-Line: Figure B3690, sizes ½ inch through 8 inches.
3. Or Approved Equal

C. Channel Type

1. General Use

a. Unistrut
b. Anvil: Power Strut
c. B-Line; Strut System
d. Or Approved Equal

2.4 PIPE SADDLES

A. Provide 90-degree to 120-degree pipe saddle for pipe 6 inches and larger with baseplates drilled for anchors bolts.

1. Sizes 20 inches through 60 inches, Piping Technology & Products, Inc.; Figure 2000.
2. Or Approved Equal

B. Saddle Supports, Pedestal Type

1. Minimum standard weight pipe stanchion, saddle, and anchoring flange.
2. Nonadjustable Saddle: MSS SP, Type 37 with U-bolt

a. B-Line; Figure B3090, sizes 3/4 inch through 36 inches with B3088S base
b. Anvil: Figure 259; sizes 4 inch through 36 inches with Figure 63C base
c. Or Approved Equal

3. Adjustable Saddle: MSS SP 58, Type 38 without clamp

a. B-Line; Figure B3093, sizes 1 inch through 36 inches with Figure B3088S base.
b. Anvil: Figure 264, sizes 2-1/2 inch through 36 inches with Figure 62C base.
c. Or Approved Equal

2.5 CHANNEL TYPE SUPPORT SYSTEMS

A. Channel Size: 12-gauge, 1-5/8-inch wide minimum steel, or 1-1/2-inch wide, minimum FRP.

B. Members and Connections: Design for loads using one-half of manufacturer's allowable loads.

C. Fasteners: Vinyl ester fiber, polyurethane base composite nuts and bolts, or encapsulated steel fasteners.

D. Manufacturers and Products:

1. General Use

a. B-Line; Strut System.
b. Unistrut
c. Anvil; Power-Strut.
d. Or Approved Equal

2.6 CLAMPS AND BEAM ATTACHMENTS

A. Beam Clamps:

1. Shall be used for suspending hanger rod from flanged beam and shall distribute the load equally on both sides of the beam.
2. MSS SP-58 Type 21, Type 28, Type 30
3. ASTM A36, steel or ASTM A181, forged steel.
4. Clamp Size: Based on load to be supported and load configuration.
5. Anchoring: Locknuts and cup-point set screws.
6. Reversible top or bottom flange.
7. Manufacturers:

a. B-Line;
b. Anvil;
c. Or Approved Equal

B. Offset Clamps:

1. Shall be used to support pipe offset from the floor or wall.
2. Double leg, two-piece.

a. B-Line; B3148; sizes ¾ inch through 12 inches
b. Anvil; Figure 103; sizes ¾ inch through 8 inches
c. Or Approved Equal

C. Welded Beam Attachment: MSS SP 58, Type 22

1. B-Line; FigureB3083, sizes 3/8”-16 through 2”-4 ½ rod
2. Anvil: Figure 66, sizes 3/8 inch through 3-1/2 inch

2.7 ELBOW AND FLANGE SUPPORTS

A. Elbow and Adjustable Stanchion: Sizes 2 inches through 18 inches, Anvil; Figure 62C base or approved equal

B. Elbow with Nonadjustable Stanchion: Sizes 2-1/2 inches through 42 inches, Anvil; Figure 63A or 63B base or approved equal.

C. Flange Support with Adjustable Base: Sizes 2 inches through 24 inches, Standon; Model S89 or approved equal.

2.8 CONCRETE DUCT SPACERS

A. Carlon Snap-N-Stac Spacers

1. Can be installed: horizontally, vertically, or turned up-right
2. Fits duct sizes: 2”, 3”, 4”, 5”, 6”, and 8”
3. Material is: Nonmetallic, noncorrosive, and nonconductive

    a. Carlon is NOT responsible for Snap-Loc Spacers used in direct bury applications, but it is the responsibility of the design engineer and contractor

B. Carlon Snap-Loc Spacers

1. Provides: stability, constant separation, and relieve direct stress for duct materials encased in concrete and direct bury applications
2. Side dovetail rail and groove design

    a. Allows for interchangeability of conduit spacer sizes while maintaining horizontal stability

3. Nonmetallic Snap-Loc Spacers designed for nonmetallic duct with maximum outside dimension (O.D.) as specified in NEMA: TC-2, TC-6 & 8, TC-10 and ASTM F512

C. Carlon Snap-Loc Reducers

1. 1” and 2” Snap-Loc Reducers allow fixturing of 1” or 2” conduit inside larger spacers

D. Suggested Specification

1. Duct/Conduit Bank shall be encased in concrete with at least 3” of concrete at top and bottom, with 2” of concrete on each side. A horizontal and vertical separation between the ducts of (1”, 1.5”, 2”, 3”) shall be maintained by installing Carlon high-impact spacers with horizontal and vertical locking intervals of (8, 9, or 10) feet.

2.9 CARRIER PIPE SPACERS WITHIN CARRIER PIPE

A. Casing spacers are configured for pipe clusters that carry several pipes through the same casing and are used to center: water, sewer, gas, and other fluids in the casing

1. Westatlantic Tech Corp

a. WA-NM-M Casing Spacers

a. Non-metallic casing spacers with wheel rollers are available
b. Carrier pipes separated in holding cluster, roller wheels provide friction-reducing features for the pull through casing
c. The casing chamber remains dry and the ends are sealed by EDPM or NBR elastomer with stainless steel compression plates

b. Bundle Pipe Casing Spacers

a. Multi-pipe casing spacers for larger pipe clusters
b. Casing spacer clamp band material is 304L stainless steel or galvanized steel
c. Steel containment bands are combined with non-metallic wheel roller elements

2. Advance Products and System (APS)

a. Stainless Steel Band Spacers and Insulators (Model SSI)

a. SSI 8 Model: Width = 8”, recommended for carrier pipe 4”-36”
b. SSI 12 Model: Width = 12”, recommended for carrier pipe 36”-120” and larger
c. Stainless steel band spacers are recommended for every 6-8 feet of pipeline
d. Bands are constructed of 14-gauge stainless steel (304-grade) with a standard 0.09” PVC or EPDM liner

b. Steel Band Spacers and Insulators (Model SI)

a. SI 8 Model: Width = 8”, recommended for carrier pipe 4”-36”
b. SI 12 Model: Width = 12”, recommended for carrier pipe 36”-120” and larger
c. Steel band casing insulators are ideal for heavy pipe
d. Band is constructed of 14-gauge steel
e. Thermoplastic powder coating and fusion-bonded coating provide corrosion resistance (10-15 mils with 90 mil thick PVC liner)
f. Long casing sections are recommended every 6-8 feet

c. Polyethylene Casing and Insulators (Model CI)

a. Good for: most sizes of schedule 40 & 80 PVC, C900, SDR 21 & 26 plastic pipe, metal pipe up to 60”, and 12” or smaller ductile iron
b. Two halves are used to construct 1”-12” spacers, while 14” and above are multi-segmented
c. Polyethylene casing insulators are recommended for every 5 feet of pipe
d. Sizes are available for 1”-60” pipe, with a standard runner height of 1”

e. APS polyethylene casing insulators must not exceed 35 in-lbs of torque

2.10 PIPE GUIDES

A. Intermediate Guides:

1. Type: Hold down pipe guide

a. Shall prevent longitudinal or lateral movement of pipe

a. B-Line; Figure B3256 sizes 2 inch through 30 inches
b. Or Approved Equal

2. Type: U-bolts with 4 hex nuts to provide nominal 1/8 inch to ¼ inch clearance around pipe; MSS SP 58 Type 24

a. Shall be used for support, anchor, or guide of pipe

a. B-Line; Figure B3188 and Figure B3188NS, sizes ½ inch through 30 inches
b. Anvil; Figure 137 and Figure 137S, sizes ½ inch through 36 inches
c. Or Approved Equal

B. Alignment Guides:

1. Type: Spider

a. Shall direct thermal expansion of insulated or non-insulated pipe in direction permitted by expansion joints or loops
b. Two or more guides shall be used on both sides of expansion joint or loop

a. B-Line; Figure B3281 through B 3287, sizes 1-1/2 inch through 24 inches
b. Anvil; Figure 255, sizes ½ inch through 24 inches
c. Or Approved Equal

2.11 PIPE ANCHORS

A. Type: Anchor chair with U-bolt strap

1. Shall be used to anchor pipe to structure

a. B-Line; Figure 3147A and 3147B, sizes ½ inch through 24 inches
b. Or Approved Equal

2.12 ACCESSORIES

A. Anchor Bolts:

1. Size and Material: ½-inch minimum diameter, and as specified in Section 0 55 00, Metal Fabrications.

2. Bolt Length (Extension Above Top of Nut):

    a. Minimum Length: Flush with top of nut preferred. If not flush, shall be no more than one thread recessed below top of nut.
    b. Maximum Length: No more than a full nut depth above top of nut.

B. Dielectric Barriers:

1. Plastic coated hangers, isolation cushion, or tape.
2. Manufacturer:

    a. B-Line; B1999 Vibra Cushion.
    b. B-Line; Iso Pipe, Isolation Tape.
    c. Or Approved Equal

C. Insulation Shields:

1. Type: Galvanized steel or stainless steel, MSS SP 58, Type 40.
2. Manufacturers:

    a. B-Line; Figure B3151, sizes ½ inch through 24 inch.
    b. Anvil; Figure 167, sizes ½ inch through 24 inches.
    c. Or Approved Equal

D. Welding Insulation Saddles:

1. Type: MSS SP 58, Type 39.
2. Manufacturers:

    a. B-Line; Figure Series B3160, sizes ½ inch through 24 inches.
    b. Anvil; Figure Series 160, sizes 1 inch through 36 inches.
    c. Or Approved Equal

E. Plastic Pipe Support Channel:

1. Type: Continuous support for plastic pipe and to increase support spacing
2. Manufacturer

    a. B-Line; Figure Series B3106V, sizes ½ inch through 6 inches with Figure B3106 Vee bottom hanger.
    b. Or Approved Equal

F. Hanger Rods, Clevises, Nuts, Sockets, and Turnbuckles: In accordance with MSS SP 58.

G. Attachments:

1. Concrete Insert: MSS SP 58, Type 18, continuous channel insert with load rating not less than that of hanger rod it supports.
2. Concrete Attachment Plates:

a. B-Line; Figure B3084, Figure B3085, or Figure B3086 with B3201 to attach center lug.
b. Anvil: Figure 47, Figure 49, or Figure 52.
c. Or Approved Equal

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 31 00 – Project Management and Coordination.

B. Verify field dimensions as indicated on Drawings.

3.2 INSTALLATION

A. Obtain permission from Engineer before using powder-actuated anchors.

B. Obtain permission from Engineer before drilling or cutting structural members.

C. Inserts:

1. Install inserts for placement in concrete forms.
2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 in and larger.
4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut flush with top of or recessed into and grouted flush with slab.

D. Pipe Hangers and Supports:

1. Install according to: MSS SP 58.
2. Support horizontal piping as indicated on Drawings.
3. Install hangers with minimum 1/2 in space between finished covering and adjacent Work.
4. Place hangers within 12 in of each horizontal elbow.
5. Use hangers with 1-1/2 in minimum vertical adjustment.
6. Support horizontal cast iron pipe adjacent to each hub, with 5 ft maximum spacing between hangers.
7. Support vertical piping at every other floor. Support vertical cast iron pipe at each floor at hub.
8. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.
9. Support riser piping independently of connected horizontal piping.
10. Provide copper-plated hangers and supports for copper piping or sheet lead packing between hanger or support and piping.
11. Design hangers for pipe movement without disengagement of supported pipe.

12. Support piping independently so that equipment is not stressed by piping weight or expansion in piping system.
13. Support large or heavy valves, fittings, and appurtenances independently of connected piping.
14. Support no pipe from pipe above it.
15. Support pipe at changes in direction or in elevation, adjacent to flexible joints and couplings, and where shown.
16. Provide welded steel brackets where piping is to be run adjacent to building walls or columns.
17. Do not use adhesive anchors for attachment of supports to ceiling or walls.
18. Use beam clamps where piping is to be suspended from building steel.
19. Brace hanging pipes against horizontal movement by both longitudinal and lateral sway bracing and to reduce movement after startup.
20. Install lateral supports for seismic loads at changes in direction.
21. Install pipe anchors where required to withstand expansion thrust loads and to direct and control thermal expansion.
22. Insulated Piping: Provide two bolted clamps designed to accommodate insulated piping.
23. Use offset clamps where pipes are indicated as offset from wall surfaces.
24. Repair mounting surfaces to original condition after attachments are completed.

E. Insulation:

1. Provide clearance in hangers and from structure and other equipment for installation of insulation.
2. Conform to 40 42 13 - Process Piping Insulation.

F. Equipment Bases and Supports:

1. Provide housekeeping pads as detailed on Drawings.
2. Using templates furnished with equipment, install anchor bolts and accessories for mounting and anchoring equipment.
3. Construct supports of steel members or formed steel channel. Brace and fasten with flanges bolted to structure.
4. Provide rigid anchors for pipes after vibration isolation components are installed. Comply with

G. Prime Coat:

1. Prime coat exposed steel hangers and supports.
2. Conform to Section 09 96 00 – High-Performance Coatings.
3. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

3.3 ATTACHMENTS

A. Standard Pipe Supports

1. Horizontal Suspended Piping:

a. Single Pipes: Clevis hangers or adjustable swivel split-ring.

b. Grouped Pipes: Trapeze hanger system.

2. Horizontal Piping Supported from Walls:

a. Single Pipes: Wall brackets, or attached to wall, or to wall mounted framing with anchors.
b. Stacked Piping: Wall mounted framing system and "J" hangers acceptable for pipe smaller than 3-inch.
c. Pipe clamp that resists axial movement of pipe through support is not acceptable. Use pipe rollers supported from wall bracket.

3. Horizontal Piping Supported from Floors/Roof:

a. Saddle Supports:

a. Pedestal Type, elbow and flange.
b. Provide minimum 1-1/2-inch grout beneath baseplate.

b. Floor Mounted Channel Supports:

a. Use for pipe smaller than 3-inch running along floors and in trenches at pipe elevations lower than can be accommodated using pedestal pipe supports.
b. Attach channel framing to floors with baseplate on minimum 1-1/2-inch non-shrink grout and with anchor bolts.
c. Attach pipe to channel with clips or pipe clamps.

c. Concrete Cradles: Use for pipe larger than 3 inches along floor and in trenches at pipe elevations lower than can be accommodated using stanchion type.

4. Vertical Pipe: Support with wall bracket and elbow support, or riser clamp on floor penetration

B. Standard Attachments:

1. New Concrete Ceilings: Concrete inserts, concrete attachment plates, or concrete anchors as limited below:

a. Single point attachment to ceiling allowed for only ¾-inch rod and smaller (8 inches and smaller pipe).
b. Where there is vibration or bending considerations, do not connect a single pipe support hanger rod directly to a drilled concrete anchor (single point attachment) regardless of size.

2. Existing Concrete Ceilings: Channel type support with minimum of two anchor points, concrete attachment plates or concrete anchors as limited below:

a. Single point attachment to ceiling is allowed only for ¾-inch rod and smaller (8 inches and smaller pipe).
b. Where there is a vibration or bending considerations do not connect a single pipe support hanger rod directly to a drilled concrete anchor (single point attachment) regardless of size.

a. These lines include air operated diagram pumps and other lines.

c. Steel Beams: I-beam clamp or welded attachments.
d. Wooden Beams: Lag screws and angel clips to members not less than 2-1/2 inches thick
e. Concrete Walls: Concrete inserts or brackets or clip angles with concrete anchors.
f. Concrete Beams: Concrete inserts, or if inserts are not used attach to vertical surface similar to concrete wall. Do not drill into beam bottom.

C. Saddles for Steel or Concrete Pipe: Provide 90-degree to 120-degree pipe saddle for pipe sizes 6 inches and larger when installed on top of steel or concrete beam or structure, pipe rack, trapeze, or where similar concentrated point supports would be encountered.

D. Intermediate and Pipe Alignment Guides:

1. Provide pipe alignment guides, or pipe supports that provide same function, at expansion joints and loops.
2. Guide pipe on each side of expansion joint or loop at 4 pipe and 14 pipe diameters from each joint or loop.
3. Install intermediate guides on metal framing support systems not carrying pipe anchor or alignment guide.

E. Accessories:

1. Insulation Shield: Install on insulated piping with oversize rollers and supports.
2. Welding Insulation Saddle: Install on insulated steel pipe with oversize rollers and supports.
3. Dielectric Barrier:

a. Provide between painted and galvanized carbon steel members and copper or stainless-steel pipe or between stainless steel supports and nonstainless steel ferrous metal piping.
b. Install rubber wrap between submerged metal pipe and oversized clamps.

F. Pipe Hanger Spacing:

1. Pipe Material: Ductile Iron Pipe

a. Size: 8 Inches and Under
b. Maximum Hanger Spacing: Maximum span limited to that for standard weight steel pipe for water service.

a. MSS SP 58 Table 3

c. Hanger Rod Diameter: MSS SP 58 Table 4

2. Pipe Material: Ductile Iron Pipe

a. Size: 10 Inches and Larger
b. Maximum Hanger Spacing: Maximum span limited to 20 feet.

a. MSS SP 58 Table 3

c. Hanger Rod Diameter: MSS SP 58 Table 4

3. Pipe Material: ABS.

   a. Maximum Hanger Spacing: 4 feet.
   b. Hanger Rod Diameter: 3/8 inch.

4. Pipe Material: Aluminum.

   a. Maximum Hanger Spacing: 10 feet.
   b. Hanger Rod Diameter: 1/2 inch.

5. Pipe Material: Cast iron.

   a. Maximum Hanger Spacing: 5 feet.
   b. Hanger Rod Diameter: 5/8 inch.

6. Pipe Material: Cast Iron, with 10-foot length of pipe.

   a. Maximum Hanger Spacing: 10 feet.
   b. Hanger Rod Diameter: 5/8 inch.

7. Pipe Material: CPVC.

   a. Size: 1 inch and smaller.
   b. Maximum Hanger Spacing: 3 feet.
   c. Hanger Rod Diameter: 1/2 inch.

8. Pipe Material: CPVC.

   a. Size: 1-1/4 inches and larger.
   b. Maximum Hanger Spacing: 4 feet.
   c. Hanger Rod Diameter: 1/2 inch.

9. Pipe Material: Copper tube.

   a. Size: 1-1/4 inches and smaller.
   b. Maximum Hanger Spacing: 6 feet.
   c. Hanger Rod Diameter: 1/2 inch.

10. Pipe Material: Copper tube.

    a. Size: 1-1/2 inches and larger.
    b. Maximum Hanger Spacing: 10 feet.
    c. Hanger Rod Diameter: 1/2 inch.

11. Pipe Material: Fiberglass:

    a. Maximum Hanger Spacing: 4 feet.
    b. Hanger Rod Diameter: 1/2 inch.

12. Pipe Material: Polybutylene.

    a. Maximum Hanger Spacing: 2.7 feet.
    b. Hanger Rod Diameter: 3/8 inch.

13. Pipe Material: Polypropylene.

    a. Maximum Hanger Spacing: 4 feet.
    b. Hanger Rod Diameter: 3/8 inch.

14. Pipe Material: PVC.

    a. Maximum Hanger Spacing: 4 feet.
    b. Hanger Rod Diameter: 3/8 inch.

15. Pipe Material: Steel.

    a. Size: 3 inches and smaller.
    b. Maximum Hanger Spacing: 12 feet.
    c. Hanger Rod Diameter: 1/2 inch.

16. Pipe Material: Steel or Stainless Steel.

    a. Size: 4 inches and larger.
    b. Maximum Hanger Spacing: 12 feet.
    c. Hanger Rod Diameter: 5/8 inch.

END OF SECTION 40 05 07

SECTION 40 05 31 - THERMOPLASTIC PROCESS PIPE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. PVC pipe, tube, and fittings.

B. Related Requirements:

1. Section 40 05 07 – Hangers and Supports for Process Piping
2. Section 40 05 13 – Common Requirements for Process Piping
3. Section 40 05 51 – Common Requirements for Process Valves

1.2 REFERENCE STANDARDS

A. American Society of Mechanical Engineers:

1. ASME B1.1 - Unified Inch Screw Threads (UN and UNR Thread Form).
2. ASME B1.20.1 - Pipe Threads, General Purpose (Inch).
3. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800
4. ASME B16.5 - Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys.
5. ASME B16.20 - Metallic Gaskets for Pipe Flanges.
6. ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges.
7. ASME B31.3 - Process Piping Guide.

B. ASTM International:

1. ASTM A193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
2. ASTM A194 - Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
3. ASTM D1784 - Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
4. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
5. ASTM D2241 - Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
6. ASTM D2464 - Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
7. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
8. ASTM D2467 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.

9. ASTM D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
10. ASTM D2837 - Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products.
11. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings.
12. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
13. ASTM D3222 - Standard Specification for Unmodified Poly(Vinylidene Fluoride) (PVDF) Molding Extrusion and Coating Materials.
14. ASTM D3892 - Standard Practice for Packaging/Packing of Plastics.
15. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
16. ASTM F656 - Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings.

C. American Water Works Association:

1. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Transmission and Distribution.
2. AWWA C905 – Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 In. Through 48 In.
3. AWWA C906 - Polyethylene (PE) Pressure Pipe and Fittings, 4 In. (100 mm) Through 63 In. (1,600 mm), for Water Distribution and Transmission.

D. NSF

1. NSF / ANSI 14 – Plastic Piping and Components and Related Materials
2. NSF/ANSI 61 – Drinking Water System Components – Health Effects.

E. PVC Pipe Association

1. UNI-B-06-Recommended Low-Pressure Air Testing of Installed Sewer Pipe.

1.3 AMBIENT CONDITIONS

A. Section 01 50 00 - Temporary Facilities and Controls: Requirements for ambient condition control facilities for product storage and installation.

B. Temperature: Do not install pipe when temperature is below 40 ºF (4.4 ºC) or above 90 ºF (32.2 ºC) if pipe is exposed to direct sunlight.

C. Ultraviolet (UV) Protection: Provide pipe installed above ground or outside with UV protection.

PART 2 - PRODUCTS

2.1 PVC PIPE, TUBE, AND FITTINGS

A. Manufacturers:

1. Eslon Thermoplastics; Charlotte, NC
2. R&G Sloane, Sun Valley, CA
3. Harvel Plastics, Easton, PA
4. LCP Chemicals & Plastics, Colfax, NC
5. Bristol Corp., Bristol, IN.
6. Or Approved Equal.

B. PVC Pipe and Fittings (for non-potable service):

1. Pipe:

a. Comply with ASTM D1785
b. Schedule 80

2. Fittings:

a. Comply with ASTM D2467
b. Joints: Socket type, solvent welded; comply with ASTM D2855
c. Solvent Cement: Comply with ASTM D2564

C. PVC Tube and Fittings:

1. Tube:

a. Clear.
b. Size and Wall Thickness: schedule 80.

2. Fittings: Compression type; materials suitable for application.
3. Threads: Straight; ASME B1.1.

2.2 ACCESSORIES

A. Flange Bolting: Stainless steel, ASTM A193 Grade 8B hex head bolts and ASTM A194 Grade 8 hex head nuts.

B. Flange Gaskets: Full faced, ethylene propylene diene monomer (EPDM), according to ASME B16.21.

C. Push-On Joint Seals:

D. Solvent Cement:

1. PVC Piping: ASTM D2564.

E. Tracer Wire: #12 AWG copper clad steel insulated wire, insulation color per pipe service.

F. Detectible Underground Marking Tape: underground marking tape shall be a minimum 3" width, detectable marking tape, with a minimum 5.0 mil overall thickness. Tape shall be manufactured using a 0.8 mil clear virgin polypropylene film, reverse printed and laminated to a 0.35 mil solid aluminum foil core, and then laminated to a 3.75 mil clear virgin polyethylene film. Tape shall be printed using a diagonally striped design for maximum visibility, and meet the APWA Color-Code standard for identification of buried utilities. Detectable marking tape shall be Pro-Line Safety Products or approved equal and made in the USA.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install piping and components according to the following:

1. Section 40 05 13 – Common Work Results For Process Piping
2. ASME B31.3 for above ground service
3. AWWA C605 for potable water service
4. ASTM D2774 for non-potable underground pressure service
5. ASTM D2321 for non-potable underground gravity service

B. Joining:

1. Primers and Cleaners: ASTM F402.
2. PVC Solvent-Cemented Joints: ASTM D2855.

C. Tracer Wire shall be installed on all non-metallic lines. The contractor shall perform a continuity test on all tracer wire in the presence of the engineer. Tracer wire shall be run along the top of the pipe and secured at intervals of 10' with wire or tape. The tracer wire shall be brought up into all valve and meter boxes so as to be readily accessible to system operators. All wire splices and connections shall be tied and tightly taped with insulated electrical tape.

D. A detectable marking tape shall be installed over all nonmetallic lines by the Contractor. Care will be taken to insure that the buried marking tape will bear the words "CAUTION-PIPE LINE BURIED BELOW." The detectable marking tape will be buried 4 to 6 in. below finish grade. The tape should be placed into backfill and allowed to settle into place in the backfill.

3.2 TESTING:

A. Clean lines by flushing or other means before testing begins.

B. Testing may be dangerous if a line is improperly prepared. The Contractor shall develop and put in place proper safety procedures when performing testing.

C. PVC pipe for pressure service will be tested in accordance with AWWA C600.

END OF SECTION 40 05 31

THIS PAGE INTENTIONALLY LEFT BLANK

40 05 51 - COMMON REQUIREMENTS FOR PROCESS VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Valves.
2. Valve actuators.

B. Conform to the requirements of Section 40 05 51 - Common Requirements for Process Valves

C. Related Requirements:

1. Section 03 30 00 – Cast-in-Place Concrete
2. Section 09 96 00 – High-Performance Coatings
3. Division 40 – Process Interconnections

1.2 REFERENCE STANDARDS

A. American Water Works Association:

1. AWWA C541 - Hydraulic and Pneumatic Cylinder and Vane-Type Actuators for Valves and Slide Gates.
2. AWWA C542 - Electric Motor Actuators for Valves and Slide Gates.
3. AWWA C550 - Protective Interior Coatings for Valves and Hydrants.

B. ASTM International:

1. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.
2. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.

C. Manufacturers Standardization Society:

1. MSS SP-25 - Standard Marking System for Valves, Fittings, Flanges, and Unions.

D. National Electrical Manufacturers Association:

1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

E. NFPA:

1. NFPA 70 - National Electrical Code (NEC).

F. NSF International:

1. NSF 61 - Drinking Water System Components - Health Effects.
2. NSF 372 - Drinking Water System Components - Lead Content.

G. UL:

1. Equipment Directory.

1.3 COORDINATION

A. Section 01 31 00 – Project Management and Coordination.

B. Coordinate Work of this Section with piping, equipment, and appurtenances.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data:

1. Submit manufacturer information for actuator with model number and size indicated.
2. Submit valve cavitation limits.

C. Shop Drawings: Indicate parts list, materials, sizes, position indicators, limit switches, control system, actuator mounting, wiring diagrams, and control system schematics.

D. Valve Schedule: Indicating the service, size, and connections, make, model number and any special features such as chain wheel operators, etc.

E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

F. Certification of Valves Larger than 12 Inches: Furnish certified copies of hydrostatic factory tests, indicating compliance with applicable standards.

G. Delegated Design Submittals: Submit signed and sealed Shop Drawings with design calculations and assumptions for sizing of control valves.

H. Manufacturer Instructions: Submit installation instructions and special requirements.

I. Source Quality-Control Submittals: Indicate results of shop/factory tests and inspections.

J. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections, including factory-applied coatings.

K. Qualifications Statement:

1. Submit qualifications for manufacturer and licensed professional.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations of valves and actuators.

1.6 QUALITY ASSURANCE

A. Maintain clearances as indicated on Drawings and Shop Drawings.

B. Ensure that materials of construction of wetted parts are compatible with process liquid.

C. Materials in Contact with Potable Water: Certified to NSF 61 and NSF 372.

D. The manufacturer shall be required to furnish at the time of delivery an affidavit of compliance stating the valve and all materials used conform in every respect to the applicable performance of the appropriate AWWA Standard, and these supplementary specifications and that all tests have been performed with test requirements having been met. Test requirements shall be performed and test records furnished to the engineer prior to shipment.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum twenty years' documented experience

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Prepare valves and accessories for shipment according to latest edition of AWWA C500, Section 31 and:

1. Seal valve ends to prevent entry of foreign matter into valve body.
2. Box, crate, completely enclose, and protect valves and accessories from accumulations of foreign matter.

D. Store materials according to manufacturer instructions.

E. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Protect valve ends from entry of foreign materials by providing temporary covers and plugs.
3. Provide additional protection according to manufacturer instructions.

1.9 TOOLS AND SPARE PARTS

A. Provide to the Owner, one operating wrench for every 10 valves of each type (but not less than 2 wrenches per type), not equipped with hand wheels or levers.

B. The manufacturer shall furnish any special tools necessary to disassemble, service, repair, and adjust the equipment.

1.10 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

1.11 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. The Manufacturer and Contractor shall furnish a warranty extending twelve (12) months after substantial completion date.

PART 2 - PRODUCTS

2.1 VALVES

A. Description: Valves, operator, actuator, handwheel, chainwheel, extension stem, floor stand, worm and gear operator, operating nut, chain, wrench, and other accessories as required.

B. General:

1. All packing, gaskets, discs, seats, diaphragms, lubricants, etc., shall conform to recommendations of the valve manufacturer for the intended service.
2. All valves shall be manufacturer's standard of the design which the manufacturer recommends for the service intended.
3. Each valve shall bear the maker's name or trademark or reference symbol to indicate the service conditions for which it is guaranteed.
4. All valves for use with copper tubing shall have solder type connections.
5. All screw end valves shall be threaded according to the American Standard for Pipe Threads No. B2.1.
6. Flange end valves shall have connecting end flanges in accordance with the B16.1, Class 125 Series of the American Standards Association for type valves covered in the Standard, and in accordance with the Manufacturer's Standardization Society Standard Practice for bronze valves corresponding to the maximum pressure and service for which the valve is to be used.

C. Valve Ends: Compatible with adjacent piping system.

D. Operation:

1. Open by turning counterclockwise; close by turning clockwise.
2. Cast directional arrow on valve or actuator with OPEN and CLOSE cast on valve in appropriate location.

E. Valve Marking and Labeling:

1. Marking: Comply with MSS SP-25.
2. Labeling: As specified in Section 40 05 53 - Identification for Process Piping.

F. Valve Construction:

1. Bodies: Rated for maximum temperature and pressure to which valve will be subjected as specified in valve Sections.
2. Bonnets:

   a. Flanged to body and of same material and pressure rating as body.
   b. Furnish glands, packing nuts, or yokes as specified in valve Sections.

3. Stems and Stem Guides:

   a. Materials and Seals: As specified in valve Sections.
   b. Bronze Valve Stems: According to ASTM B584.
   c. Space stem guides 10 feet o.c.
   d. Submerged Stem Guides: Type 304 stainless steel.

4. Nuts and Bolts: As specified in Section 05 50 00 - Metal Fabrications.

G. Valve Type:

1. Ball Valves: As specified in Section 40 05 63 – Ball Valves.
2. Butterfly Valves: As specified in Section 40 05 64 – Butterfly Valves.

2.2 VALVE ACTUATORS

A. Description: Manual, pneumatic and electric motor actuators.

B. Provide actuators per specification Section 40 05 57 – Actuators for Process Valves and Gates

2.3 INSULATION

A. As specified in Section 40 42 13 - Process Piping Insulation or as indicated on Drawings.

2.4 FINISHES

A. Valve lining and coating: Comply with AWWA C550.

B. Exposed Valves: As specified in Section 09 96 00 – High-Performance Coatings.

C. Do not coat flange faces of valves unless otherwise specified.

2.5 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. Testing: Test valves according to manufacturer's standard testing protocol, including hydrostatic, seal, and performance testing.

C. Certificate of Compliance:

1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
2. Specified shop tests are not required for Work performed by approved manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 31 00 – Project Management and Coordination: Requirements for installation examination

B. Verify that piping system is ready for valve installation.

3.2 INSTALLATION

A. Install valves, actuators, extensions, valve boxes, and accessories according to manufacturer instructions.

B. Firmly support valves to avoid undue stresses on piping.

C. Valves shall be installed with the stems positioned in the horizontal or above the centerline of the pipe unless otherwise shown on the Drawings.

D. Operators shall be positioned so that they do not interfere with pedestrian traffic.

E. Valve operators which are 7 ft 0 in. or more above the operating floor or platform shall be chain wheel operated.

F. Where necessary for operations as described above, valves shall be bevel or spur gear operated. Plug valve 6 in. and larger shall be gear operated.

G. Coat studs, bolts and nuts with anti-seizing lubricant.

H. Clean field welds of slag and splatter to provide a smooth surface.

I. Install valves with stems upright or horizontal, not inverted.

J. Install brass male adapters on each side of valves in copper-piped system and solder adapters to pipe.

K. All buried valves shall have a 2” operating nut and handwheels for all exposed valves.

L. Install 3/4-inch ball valves with cap for drains at main shutoff valves, low points of piping, bases of vertical risers, and equipment.

M. Install valves with clearance for installation of insulation and to allow access.

N. Provide access where valves and fittings are not accessible.

O. Pipe Hangers and Supports: As specified in Section 40 05 07 - Hangers and Supports for Process Piping.

P. Comply with Division 40 - Process Interconnections for piping materials applying to various system types.

Q. Install insulation as specified in Section 40 42 13 - Process Piping Insulation and as indicated on Drawings.

3.3 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.

B. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

C. Valve Field Testing:

1. Test for proper alignment.
2. If specified by valve Section, field test equipment to demonstrate operation without undue noise, vibration, or overheating.
3. Architect/Engineer will witness field testing.

END OF SECTION 40 05 51

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 40 05 53 - IDENTIFICATION FOR PROCESS PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Nameplates.
2. Tags.
3. Stencils.
4. Pipe markers.
5. Ceiling tacks.
6. Labels.
7. Lockout devices.

B. Related Requirements:

1. Division 40 – Process Interconnections
2. Division 43- Process Gas and Liquid Handling, Purification and Storage Equipment
3. Division 46 – Water and Wastewater Equipment

1.2 REFERENCE STANDARDS

A. American Society of Mechanical Engineers:

1. ASME A13.1 - Scheme for the Identification of Piping Systems.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer's catalog literature for each product required.

C. Shop Drawings: Submit list of wording, symbols, letter size, and color-coding for mechanical identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

D. Samples: Submit one tag, label, and pipe markers for each size used on Project.

E. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.

F. Manufacturer's Certificate: Certify that products meet or exceed specified requirement.

G. Qualifications Statement:

1. Submit qualifications for manufacturer.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for closeout procedures.

B. Project Record Documents: Record actual locations of tagged valves; include valve tag numbers.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance materials.

B. Extra Stock Materials: Furnish one container of spray-on adhesive.

C. Tools: Furnish special tools and other devices required for Owner to reinstall tags.

1.6 QUALITY ASSURANCE

A. Conform to ASME A13.1 for color scheme for identification of piping systems and accessories.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum ten years' documented experience.

PART 2 - PRODUCTS

2.1 NAMEPLATES

A. Manufacturers:

1. Craftmark Pipe Markers
2. Kolbi Pipe Marker Co.
3. Seton Identification Products
4. Or Approved Equal

B. Description: Equipment nameplates shall be engraved or stamped on stainless steel and fastened to the equipment in an accessible location with oval head stainless steel screws or drive pins. Nameplates shall at a minimum contain manufacturers name and address, year of manufacture, serial number, speed (if applicable) and other applicable information.

2.2 TAGS

A. Plastic Tags:

1. Manufacturers:

a. Brady ID
b. Craftmark Pipe Markers
c. Kolbi Pipe Marker Co.
d. Seton Identification Products
e. Or Approved Equal

2. Description:

a. Laminated three-layer plastic with engraved black letters on light, contrasting background color.
b. Minimum Tag Size and Configuration: 1-1/2 inches; diameter or square.

B. Metal Tags:

1. Manufacturers:

a. Brady ID
b. Craftmark Pipe Markers
c. Kolbi Pipe Marker Co.
d. Seton Identification Products
e. Or Approved Equal

2. Description:

a. Aluminum or Stainless-steel construction; stamped letters.
b. Minimum Tag Size and Configuration: 1-1/2 inches; diameter or square with finished edges.

C. Information Tags:

1. Manufacturers:

a. Brady ID
b. Craftmark Pipe Markers
c. Kolbi Pipe Marker Co.
d. Seton Identification Products
e. Or Approved Equal

2. Description:

a. Clear plastic with printed DANGER, CAUTION, WARNING, and message.
b. Minimum Tag Size: 3-1/4 by 5-5/8 inch.
c. Furnish grommet and self-locking nylon ties.

3. Tag Chart: Typewritten, letter-size list of applied tags and location, in anodized aluminum frame.

2.3 STENCILS

A. Manufacturers:

a. Kolbi Pipe Marker Co.
b. Seton Identification Products
c. Or Approved Equal

B. Description:

1. Clean-cut symbols.
2. Letters:

a. Up to 2-inch Outside Diameter of Insulation or Pipe: 1/2-inch-high letters.
b. 2-1/2- to 6-inch Outside Diameter of Insulation or Pipe: 1-inch-high letters.
c. Over 6-inch Outside Diameter of Insulation or Pipe: 1-3/4-inch-high letters

C. Stencil Paint: As specified in 09 96 00 - High-Performance Coatings; semigloss enamel.

D. Color-Coding and Lettering Size: Conform to ASME A13.1.

2.4 PIPE MARKERS

A. Color-Coding and Lettering Size: Conform to ASME A13.1.

B. Plastic Pipe Markers:

1. Manufacturers:

a. Brady ID
b. Craftmark Pipe Markers
c. Seton Identification Products
d. Or Approved Equal

2. Description:

a. Factory-fabricated, flexible, semirigid plastic.
b. Preformed to fit around pipe or pipe covering.
c. Larger sizes may have maximum sheet size with spring fastener.

C. Plastic Tape Pipe Markers:

1. Manufacturers:

a. Brady ID
b. Craftmark Pipe Markers
c. Kolbi Pipe Marker Co.

d. Seton Identification Products
e. Or Approved Equal

2. Description: Flexible, vinyl film tape with pressure-sensitive adhesive backing and printed markings.

D. Plastic Underground Pipe Markers:

1. Manufacturers:

a. Kolbi Pipe Marker Co.
b. Seton Identification Products
c. Or Approved Equal

2. Description:

a. Brightly colored, continuously printed plastic ribbon tape.
b. Minimum 6 inches wide by 4 mil thick.
c. Manufactured for direct burial service.

2.5 LABELS

A. Manufacturers:

1. Brady ID
2. Seton Identification Products
3. Or Approved Equal

B. Description:

1. Aluminum or Laminated Mylar construction.
2. Minimum Size: 1.9 by 0.75 inches.
3. Adhesive backed, with printed identification and bar code.

2.6 LOCKOUT DEVICES

A. Lockout Hasps:

1. Manufacturers:

a. Brady ID
b. Master Lock Company, LLC
c. Or Approved Equal

2. Description:

a. Anodized aluminum or reinforced nylon construction.
b. Furnish hasp with erasable label surface.
c. Minimum Size: 7-1/4 by 3 inches.

B. Valve Lockout Devices:

1. Manufacturers:

a. Brady ID
b. Master Lock Company, LLC
c. Or Approved Equal

2. Description:

a. Nylon or Steel construction.
b. Furnish device preventing access to valve operator and accepting lock shackle.

PART 3 - EXECUTION

3.1 PREPARATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.

B. Degrease and clean surfaces to receive adhesive for identification materials.

3.2 INSTALLATION

A. Install identifying devices after completion of coverings and painting.

B. Identify equipment with nameplates.

C. Identify inline pumps and other small devices with tags.

D. Identify control panels and major control components outside panels with plastic nameplates.

E. Install plastic nameplates with corrosion-resistant mechanical fasteners or adhesive.

F. Labels:

1. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer.
2. For unfinished covering, apply paint primer before applying labels.

G. Tags:

1. Install tags using corrosion-resistant chain.
2. Number tags consecutively by location.

H. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.

I. Identify valves in main and branch piping with tags.

J. Piping:

1. Identify piping, concealed or exposed, with plastic pipe markers, plastic tape pipe markers and/or stenciled painting.
2. Use tags on piping 3/4-inch diameter and smaller.
3. Identify service, flow direction, and pressure.
4. Install in clear view and align with axis of piping.
5. Locate identification not to exceed 20 feet on straight runs, including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.

K. Ceiling Tacks:

1. Provide ceiling tacks to locate valves above T-bar-type panel ceilings.
2. Locate in corner of ceiling panel closest to equipment.

END OF SECTION 40 05 53

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 40 05 57 - ACTUATORS FOR PROCESS VALVES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Manual actuators

B. Related Requirements:

1. Section 09 96 00 - High-Performance Coatings
2. Division 40 - Process Interconnections

1.2 REFERENCE STANDARDS

A. American Bearing Manufacturers Association:

1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings
2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings

B. American Water Works Association:

1. AWWA C500 - Metal-Seated Gate Valves for Water Supply Service
2. AWWA C542 - Electric Motor Actuators for Valves and Slide Gates

C. NFPA:

1. NFPA 70 - National Electrical Code

1.3 COORDINATION

A. Section 01 31 00 - Project Management and Coordination: Requirements for coordination

B. Coordinate Work of this Section with installation of valves and accessories.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals

B. Product Data: Submit manufacturer information for actuator with model number and size indicated.

C. Shop Drawings:

1. Indicate parts list, materials, sizes, position indicators, limit switches, actuator mounting, wiring diagrams, control system, and control system schematics on assembly drawings.
2. Submit actuator Shop Drawings with valve and gate submittal.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Manufacturer Instructions: Submit special procedures and placement requirements.

F. Source Quality-Control Submittals: Indicate results of shop/factory tests and inspections.

G. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

H. Qualifications Statements:

1. Submit qualifications for manufacturer and installer.
2. Submit manufacturer's approval of installer.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations and types of actuators.

1.6 QUALITY ASSURANCE

A. Locations: Comply with NFPA 70.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years' documented experience.

B. Installer: Company specializing in performing Work of this Section with minimum three years' documented experience and approved by manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store materials according to manufacturer instructions.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.

2. Furnish temporary end caps and closures on piping and fittings and maintain in place until installation.
3. Provide additional protection according to manufacturer instructions.

1.9 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

1.10 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. The Manufacturer and Contractor shall furnish a warranty extending twelve (12) months after substantial completion date.

PART 2 - PRODUCTS

2.1 DESCRIPTION

A. Furnish gear and power actuators with position indicators.

2.2 MANUAL ACTUATORS

A. Gate Valves: Gave valves shall be fitted with cast iron hand wheels of suitable size or gear and hand wheel operators in accordance with AWWA C500.

B. Butterfly Valves: Butterfly valves 6 inches and smaller shall be lever and locking ratchet operated. Butterfly valves larger than 6 inches shall be equipped with gear and hand wheel operators. The operators shall be furnished by the manufacturer of the valve, in accordance with AWWA C504, who shall be responsible for the compatibility and adequacy of both the valve and operator. Valve operator shall be sized for the maximum torque developed by the maximum pressure in the pipeline in which the valve is to be used.

C. Plug and Ball Valves: Plug and ball valves 6 inches and smaller shall be lever and locking ratchet operated. Plug and ball valves larger than 6 inches shall be provided with gear and hand wheel operators.

D. Provide gear and power actuators with position indicators.

E. Gear-Assisted Manual Actuators:

1. Drive Type: Worm gear except where otherwise shown or specified
2. Provide totally enclosed gears.
3. Gearing: Designed for 100 percent overload.

4. Bearings:

    a. Type: Ball or Roller; comply with ABMA 9 or ABMA 11.
    b. Permanently lubricated bronze.
    c. Minimum L10 Life: 100,000 hours.

5. Maximum Operating Force: 60 lbf.
6. Handwheel: Minimum 12-inch diameter.
7. Packing: Accessible for adjustment without requiring removal of actuator from valve.

F. Chain Actuators:

1. Description:

    a. Chain actuators for shutoff valves mounted 7 feet and greater above operating floor level.
    b. Chain guides and hot-dip galvanized operating chain extending to 5-1/2 feet above operating floor level.

2. Chain Wheels: Sprocket rim type.
3. Furnish chain storage if chains may interfere with pedestrian traffic.

G. Buried Valves:

1. Comply with AWWA C500.
2. Floors:

    a. Furnish extension stems to grade, and square nuts or floor stands with position indicators.
    b. Cast-iron/Steel pipe extensions with valve boxes, covers, and operating keys.
    c. Floor Boxes: Hot-dip galvanized cast iron or steel, with bronze cover.
    d. Lid Inscription: An arrow at least 2" long showing direction of opening. The word OPEN shall also be cast on the flange.

3. Valve Boxes:

    a. Material: Cast iron.
    b. 12 Inch Diameter Valves and Smaller: Two-piece, screw type.
    c. Valves larger than 12 Inch Diameter: Three-piece, screw type.
    d. Lid Inscription: An arrow at least 2" long showing direction of opening. The word OPEN shall also be cast on the flange.

2.3 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. Provide shop inspection and testing of completed assemblies.

C. Certificate of Compliance:

1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
2. Specified shop tests are not required for Work performed by approved manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that field dimensions are as indicated on Shop Drawings.

3.2 INSTALLATION

A. Securely mount actuators using brackets or hardware specifically designed for attachment to valves.

B. Extend chain actuators to 5-1/2 feet above operating floor level.

3.3 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.

B. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

C. After installation, inspect for proper supports and interferences.

D. Repair damaged coatings with material equal to original coating as specified in Section 09 96 00 - High-Performance Coatings.

END OF SECTION 40 05 57

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 40 05 59 - STAINLESS STEEL SLIDE GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Stainless-steel slide gates.

B. Related Requirements:

1. Section 03 30 00 – Cast-In-Place Concrete
2. Section 05 50 00 – Metal Fabrications
3. Division 40 – Process Interconnections.

1.2 REFERENCE STANDARDS

A. American Water Works Association:

1. AWWA C561 - Fabricated Stainless Steel Slide Gates.

1.3 COORDINATION

A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.

B. Coordinate Work of this Section with Work of other Sections.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer's product information for system materials and component equipment.

C. Shop Drawings:

1. Indicate system materials and component equipment.
2. Submit installation and anchoring requirements, fasteners, and other details.
3. Indicate gate identification number, location, service, type, size, design pressure, operator details, stem details, and loads.
4. Detail drawings are required. General arrangement drawings and catalog cuts are not acceptable as shop drawings.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1. Certify that installation is completed according to manufacturer's instructions.

E. Manufacturer's Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

F. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

G. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

H. Manufacturer Reports:

1. Certify that equipment has been installed according to manufacturer's instructions.
2. Indicate activities on Site, adverse findings, and recommendations.

I. Qualifications Statements:

1. Submit qualifications for manufacturer and licensed professional.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for closeout procedures.

B. Project Record Documents: Record actual locations of installed slide gates and components.

C. Operation and Maintenance Data: Submit maintenance instructions for equipment and accessories.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance materials.

B. Spare Parts:

1. Furnish one set of manufacturer's recommended spare parts.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store and protect materials according to manufacturer's instructions.

1.8 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

1.9 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. The Manufacturer and Contractor shall furnish a warranty extending twelve (12) months after substantial completion date.

C. Furnish five year manufacturer's warranty that clear plastic stem covers will not crack, discolor, or become opaque.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN CRITERIA

A. Seating/Unseating Pressure:

1. Measurement: From maximum water surface to centerline of gate.

B. Minimum Vertical Loading: 50 percent of force on the gate from operating head acting on horizontal centerline of gate, multiplied by effective gate area, plus weight of slide and stem.

C. Gate Reinforcement: As required for deflection not greater than 1/360 of span or 1/16-inch, whichever is less.

D. Operating Head:

1. Safety Factor: Design gate to operate under specified operating head with safety factory of four in accordance with the latest revision of AWWA C561.

2.2 STAINLESS-STEEL SLIDE GATES

A. Manufacturers:

1. Golden Harvest
2. RW Gate Company
3. Waterman Industries
4. Whipps
5. Or Approved Equal

B. Description:

1. Comply with AWWA C561.
2. Self-contained stainless-steel slide gate, with extended frame, yoke, lifting stem attached to yoke, lift and lift support, stem, stem guide, and stem block.
3. Size: As indicated on Drawings.

4. Operating Head: As indicated on Drawings.
5. Closure: As indicated on Drawings.
6. Opening: As indicated on Drawings.
7. Mounting: As indicated on Drawings.

C. Gates:

1. Configuration:

   a. One piece.
   b. Removable.

2. Material:

   a. Type 304 stainless steel and Type 304L for welded components
   b. Comply with AWWA C561.

3. Minimum Material Thickness: 1/4 inch.
4. Size: As indicated on Drawings.

D. Yokes:

1. Material: Stainless Steel.
2. Mounting: Bolted or welded to gate frame.
3. C-channel shaped members for rigidity. Angles are not acceptable for yoke members.

E. Seats and Seals:

1. The seats and seals shall be removable and replaceable, UV stabilized UHMWPE and shall be fastened with 316 stainless steel attachment bolts. The UHMWPE seals shall be self-adjusting by means of a rubber compression cord.
2. Rubber J-seals or P-seals along the sides are not acceptable.
3. The invert seal on upward opening gates shall be EPDM and shall be fastened to the flush bottom invert member with 316 stainless steel attachment bolts.
4. Maximum Clearance between Seating Faces: 0.004 inch when gate is fully closed.

F. Frames:

1. Configuration: One piece with gussets or sandwich type guides to accommodate unseating head. Spigot-back frames are not acceptable.
2. Mounting: As indicated on Drawings.
3. Material: Type 304 stainless steel.
4. Thickness: 1/4 inch.
5. Wall mounted guides shall have a minimum weight of 9 lbs/ft. Guides for embedded frames or in-channel mounted frames shall have a minimum weight of 6.5 lbs/ft.
6. Guide extensions shall be of the C-channel shape or similar for rigidity and shall have a minimum weight of 6 lbs/ft. Angles are not acceptable for guide extensions.

G. Lifting Devices:

1. Description: Stem, lifting nut, supports, bushings, stem cover, position indicator, and gear-assisted handwheel, handwheel, gear-assisted crank, crank, or electric-motor actuator as indicated in Gate Schedule.
2. Powered Lift Devices:

    a. As specified in Section 40 05 57 – Actuators for Process Valves and Gates.
    b. Comply with AWWA C541 and AWWA C542.

H. Manual Lifting Devices:

1. Material: Ductile iron housing with bronze lift nut and stainless steel input shaft
2. Furnish grease fitting in the housing unless sealed unit is provided.
3. Furnish ball or roller bearings above and below lifting nut and to support the input shaft.
4. Suitable for operation with portable operator
5. Minimum gear ratio of 2:1
6. For non self-contained gates, the pedestal shall be constructed of 304L or 316L stainless steel with a base plate and adaptor plate with a minimum thickness of 1/2-inch.
7. Lifting Stem:

    a. Material: Type 304 stainless steel.
    b. Configuration:

        1) Rising unless otherwise shown
        2) Removable. Bolted to gate (slide) with a minimum of two bolts per stem connector

    c. Thread:

        1) Machine rolled, full depth Acme, double lead with 16 microinch finish or better. Stub threads are not acceptable.
        2) Cut threads are not acceptable.

    d. Diameter: 1-1/2 inch (minimum).
    e. Fully lubricated.

8. Stem Covers: Provide rising stem gates with clear polycarbonate covers, capped, vented, and of a length to allow full travel of gate.

2.3 FINISHES

A. Stainless-Steel Surfaces: Mill finish. Welds and weld burn passivated in accordance with ASTM A380. If bead blasting is utilized, the entire slide and entire frame shall be bead blasted.

2.4 ACCESSORIES

A. Hardware: Type 316 stainless steel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that facilities are ready to receive slide gates.

3.2 PREPARATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.

B. Clean surfaces according to manufacturer's instructions.

3.3 INSTALLATION

A. Install slide gates according to manufacturer's instructions.

B. Ensure that products are installed plumb, true, and free of warp or twist.

C. Locate operators to avoid interference with handrails and other Work. Contractor to coordinate with gate manufacturer.

D. Guides:

1. Surface and Flange Mounted:

   a. Install guides with adhesive or expansion anchors.
   b. Position guides at elevation as indicated on Drawings.

2. Recessed:

   a. Position guides at elevation as indicated on Drawings.
   b. Grout guides in place according to manufacturer's instructions.

E. Mounting

1. Non-shrink grout or a resilient gasket shall be used to seal between the gate frame and wall as recommended by the gate manufacturer. Resilient gaskets shall be used when there are wall thimbles.

F. Sealant (when mounted to wall thimble):

1. Apply 1/8-inch -thick layer of elastomeric sealant to back of frame.
2. Tighten nuts snug until sealant begins to flow beyond frame.
3. Remove excess sealant.
4. Cure sealant for minimum seven days.

5. Tighten nuts to their final positions.

G. Lubricants: Provide oil and grease as required for initial operation.

3.4 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

B. Inspection:

1. Verify alignment of gate and components.
2. Verify that gate operates smoothly and does not bind or scrape.

C. Testing:

1. Comply with AWWA C561.
2. Leakage: Not exceeding 0.05 gpm/ft of seal perimeter in the seating head and unseating head condition at the design head.

D. Manufacturer Services: Furnish services of manufacturer's representative experienced in installation of products furnished under this Section for not less than two (2) days on Site for installation, inspection, field testing, and instructing Owner's personnel in maintenance of equipment.

E. Equipment Acceptance:

1. Adjust, repair, modify, or replace components failing to perform as specified and re-inspect.
2. Make final adjustments to equipment under direction of manufacturer's representative.

F. Furnish installation certificate from equipment manufacturer's representative attesting equipment has been properly installed and is ready for startup and testing.

3.5 ADJUSTING

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for starting and adjusting.

B. Adjust slide gates to provide smooth operation.

3.6 DEMONSTRATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate equipment operation, routine maintenance, and emergency repair procedures to Owner's personnel.

3.7 ATTACHMENTS

A. Slide Gate Schedule (see Drawings)

END OF SECTION 40 05 59

SECTION 40 05 61 - GATE VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Resilient-seated gate valves.
2. Solid wedge, metal-seated gate valves.
3. General duty gate valves smaller than 3 inches.

B. As specified in Section 40 05 51 - Common Requirements for Process Valves

C. Related Requirements:

1. Division 40 - Process Interconnections

1.2 REFERENCE STANDARDS

A. American Water Works Association:

1. AWWA C515 Ductile Iron
2. AWWA C550 Fusion-bonded epoxy coatings

B. ASME International:

1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
2. ASME B16.5 - Pipe flanges and Flanged Fittings: NPS ½ through NPS 24 Metric/Inch Standard.
3. ASME B16.42 - Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300.

C. ASTM International:

1. ASTM A536 - Standard Specification for Ductile Iron Castings

PART 2 - PRODUCTS

2.1 RESILIENT-SEATED GATE VALVES

A. Manufacturers:

1. M&H Valve Co., Anniston, AL
2. Henry Pratt Co., Aurora, IL
3. Or approved equal.

B. Description:

1. As specified in Section 40 05 51 - Common Requirements for Process Valves.
2. Comply with AWWA C509; NSF Standard 61.
3. Minimum Working Pressure: 250 psig.
4. End Connections: ASME B16.1 Flanged, ANSI A21.11 Mechanical joint.
5. Gear Actuators for Manual Valves: Comply with AWWA C509.

C. Operation:

1. As specified in Section 40 05 51 - Common Requirements for Process Valves.
2. Stem: Non-rising.
3. Handwheel.
4. Furnish gear operators for valves 24 inches and larger, and chainwheel operators for valves mounted over 7 feet above operating floor.

D. Materials:

1. Wedge: Resilient ASTM A536, ductile iron, fully encapsulated with molded rubber per ASTM D429.
2. Body and Disc: ASTM A536, ductile iron, rubber Buna-N coated.
3. Stem, Stem Nuts, Glands, and Bushings: ASTM B584, bronze.
4. Connecting Hardware: Type 316 stainless steel.

2.2 SOLID WEDGE, METAL-SEATED GATE VALVES

A. Manufacturers:

1. M&H Valve Co., Anniston, AL
2. Henry Pratt Co., Aurora, IL
3. Or approved equal.

B. Description:

1. As specified in Section 40 05 51 - Common Requirements for Process Valves.
2. Comply with AWWA C500.
3. Minimum Working Pressure: 250 psig .
4. Wedge: One piece, solid.
5. End Connections: ASME B16.1Flanged, ANSI A21.11 Mechanical joint.

C. Operation:

1. As specified in Section 40 05 51 - Common Requirements for Process Valves.
2. Buried Service: Non-rising stem.
3. Interior and Exposed Service:

    a. Outside screw and yoke (OS&Y).
    b. Provide NRS valves with position indicators.

4. Gear Actuators for Manual Valves: Comply with AWWA C500.

5. Valves 24 Inches and Larger: Furnish bevel or spur gear operator.

D. Materials:

1. Comply with AWWA C500.
2. Body, Bonnet, Wedge, and Gland: ASTM A536, ductile iron.
3. Handwheel Nut: Ductile iron 2 inch.
4. Stem: Stainless steel 304.
5. Trim: Bronze B62.
6. Packing: Non-asbestos graphite.
7. Rollers and Tracks: Bronze.
8. Rubber Components: Buna-N.
9. Connecting Hardware: Type 316 stainless steel.

E. Finishes: As specified in Section 40 05 51 - Common Requirements for Process Valves.

2.3 GENERAL-DUTY GATE VALVES - 3 INCHES AND SMALLER

A. Manufacturers:

1. NIBCO Inc., Elkhart, IN
2. Watts Water Technologies, North Andover, MA
3. Or approved equal.

B. 3 Inches and Smaller:

1. Comply with MSS SP-80, Class 150.
2. Maximum Process Fluid Temperature: 366 deg. F.
3. Body and Trim: Bronze, ASTM B62.
4. Bonnet: Threaded.
5. Operation: Handwheel.
6. Inside screw with backseating stem.
7. Wedge Disc:

    a. Type: Solid.
    b. Bronze, ASTM B62.

8. Alloy seat rings.
9. End Connections: Soldered or threaded.

2.4 SOURCE QUALITY CONTROL

A. Provide shop inspection and testing of completed assembly according to AWWA C509.

B. Certificate of Compliance:

1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.

2. Specified shop tests are not required for Work performed by approved manufacturer.

PART 3 - EXECUTION

3.1 EXECUTION, INSTALLATION AND FIELD QUALITY CONTROL

A. As specified in Section 40 05 51 - Common Requirements for Process Valves: Submittal requirements for compliance with this Section.

B. According to AWWA C500, C509.

END OF SECTION 40 05 61

SECTION 40 05 63 - BALL VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal-seated ball valves.
2. Plastic ball valves (BA).

B. Conform to requirements of Section 40 05 51 – Common Requirements for Process Valves

C. Related Requirements:

1. Division 40 – Process Interconnections

1.2 REFERENCE STANDARDS

A. American Water Works Association:

1. AWWA C507 - Ball Valves, 6 In. Through 60 In.

B. ASME International:

1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
2. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
3. ASME B16.42 - Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300.

C. ASTM International:

1. ASTM D1784 - Standard Specification for Rigid PolyVinyl Chloride (PVC) Compounds and Chlorinated Poly Vinyl Chloride (CPVC) Compounds.
2. ASTM D3222 - Standard Specification for Unmodified Poly Vinylidene Fluoride (PVDF) Molding Extrusion and Coating Materials.
3. ASTM D4101 - Standard Specification for Propylene Injection and Extrusion Materials.

D. Manufacturers Standardization Society of the Valve and Fittings Industry:

1. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

PART 2 - PRODUCTS

2.1 RUBBER-SEATED BALL VALVES

A. Manufacturers:

1. Henry Pratt Company; Aurora, IL
2. APCO
3. GA
4. Or approved equal

B. 4 Inches through 48 Inches:

1. AWWA C507, Class 150.
2. Body:

    a. Material: Ductile iron, ASTM A536.
    b. Seats: Rubber.

3. Ball:

    a. Material: Cast iron, ASTM A126 or Ductile iron, ASTM A536.
    b. Bearing Seal, O-Rings, and Packing: Buna-N.

4. Shaft and Attachment Pins: Type 316 stainless steel.
5. Bearings: PTFE-lined with fiberglass backing.
6. Shaft Seals: Self-lubricating and self-adjusting.
7. Connecting Hardware: Type 316 stainless steel.
8. End Connections:

    a. Flanged: Comply with ASME B16.1.

9. Operator: Handwheel.

C. Smaller Than 4 Inches:

1. Comply with MSS SP 110.
2. Body:

    a. Type: Two piece.
    b. Material: Bronze.

3. Ball: Stainless steel.
4. Port: Full.
5. Seats: PTFE.
6. Stem: Blowout proof.
7. End Connections: Threaded, with union.
8. Operator: as scheduled
9. Finishes: As specified in Section 40 05 51 - Common Requirements for Process Valves.

2.2 PLASTIC BALL VALVES

A. Manufacturers:

1. Hayward
2. Or approved equal.

B. Description:

1. Working Pressure: 232 psig at 68 deg. F.
2. Ports: Full size.
3. End Connections:

    a. Socket Union
    b. Threaded Pipe Union.

C. Operator: Manual unless otherwise specified or shown.

D. Materials:

1. Body and Ball: PVC, CPVC, PP as specified, shown on drawings, or recommended by the manufacturer for the service conditions specified.
2. Seats: PTFE.

2.3 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. As specified in Section 40 05 51 - Common Requirements for Process Valves.

C. Testing: Test ball valves according to AWWA C507.

PART 3 - EXECUTION

3.1 EXAMINATION, INSTALLATION AND FIELD QUALITY CONTROL

A. As specified in Section 40 05 51 - Common Requirements for Process Valves

B. According to AWWA C507

END OF SECTION 40 05 63

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 40 05 64 - BUTTERFLY VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Rubber-seated butterfly valves.

B. Conform to the requirements of Section 40 05 51 - Common Requirements for Process Valves

C. Related Requirements:

1. Division 40 – Process Interconnections

1.2 REFERENCE STANDARDS

A. American Water Works Association:

1. AWWA C504 - Rubber-Seated Butterfly Valves.

B. ASME International:

1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
2. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
3. ASME B16.42 - Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300.

C. ASTM International:

1. ASTM A536 - Standard Specification for Ductile Iron Castings.
2. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
3. ASTM D3222 - Standard Specification for Unmodified Poly (Vinylidene Fluoride) (PVDF) Molding Extrusion and Coating Materials.
4. ASTM D4101 - Standard Specification for Propylene Injection and Extrusion Materials.

PART 2 - PRODUCTS

2.1 RUBBER-SEATED BUTTERFLY VALVES

A. Manufacturers:

1. DeZurik
2. Milliken; Henry Pratt Company

3. GA Industries
4. Or approved equal

B. Description:

1. Comply with AWWA C504, Class 150.
2. Minimum Working Pressure: 150 psig.
3. Shaft: Bearings shall be non-metallic and permanently lubricated.
4. Seats:

    a. Mounting: On body for valves 24 inches and smaller.
    b. Type: Field replaceable for valves larger than 30 inches.

5. Packing: V-type packing with a minimum of 4 sealing rings or multiple U-cups.
6. End Connections: Flanged end valves of short body design with 125 lb. flanged ends faced and drilled per ANSI B16.1 standard for cast iron flanges.

C. Operator:

1. As specified in Section 40 05 57 – Actuators for Process Valves and Gates
2. Gear Actuators for Manual Valves: Comply with AWWA C504.

D. Materials:

1. Body: Cast iron, ASTM A126 or ductile iron, ASTM A536 Grade 65-45-12.
2. Stem: Stainless steel.
3. Disc: Cast iron, ASTM A48, Class 4C or ductile iron, ASTM A536 Grade 65-45-12
4. Seats:

    a. Type: Resilient..
    b. Material: Buna N or EPDM for water, or as required for other services

5. Seating Surfaces: Type 316 stainless steel.
6. Bearings: Non-metallic and permanently lubricated.
7. Connecting Hardware: Type 316 stainless steel.

E. Finishes: As specified in Section 09 96 00 – High-Performance Coatings.

2.2 BUTTERFLY VALVES FOR AIR SERVICE

A. Manufacturers:

1. DeZurik
2. Henry Pratt Company
3. M & H
4. GA Industries
5. Or approved equal

B. Description:

1. Comply with AWWA C504, Class 150.
2. Minimum Working Pressure: 175 psig.
3. Shaft: Bearings shall be non-metallic and permanently lubricated.
4. Seats:

    a. Mounting: On body for valves 24 inches and smaller.
    b. Type: Field replaceable for valves larger than 30 inches.

5. Packing: V-type packing with a minimum of 4 sealing rings or multiple U-cups.
6. End Connections: Flanged end valves of short body design with 125 lb. flanged ends faced and drilled per ANSI B16.1 standard for cast iron flanges.

C. Operator:

1. As specified in Section 40 05 57 – Actuators for Process Valves and Gates
2. Gear Actuators for Manual Valves: Comply with AWWA C504.

D. Materials:

1. Body: Cast iron, ASTM A126 or ductile iron, ASTM A536 Grade 65-45-12.
2. Stem: Stainless steel.
3. Disc: Cast iron, ASTM A48, Class 4C with welded nickel edge or ductile iron, ASTM A536 Grade 65-45-12 with 316 stainless steel edge.
4. Seats:

    a. Type: Resilient.
    b. Material: EPDM for up to 250F air service.

5. Seating Surfaces: Type 316 stainless steel.
6. Bearings: Non-metallic and permanently lubricated.
7. Connecting Hardware: Type 316 stainless steel.

E. Finishes: As specified in Section 40 05 51 - Common Requirements for Process Valves.

2.3 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. As specified in Section 40 05 51 - Common Requirements for Process Valves.

C. Testing: Test butterfly valves according to AWWA C504.

PART 3 - EXECUTION

3.1 EXAMINATION, INSTALLATION AND FIELD QUALITY CONTROL

A. As specified in Section 40 05 51 - Common Requirements for Process Valves

B. According to AWWA C504.

END OF SECTION 40 05 64

SECTION 40 72 13 - ULTRASONIC LEVEL METERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Ultrasonic-level measurement devices.
2. Transmitters.

B. Related Requirements:

1. Division 26 – Electrical

1.2 REFERENCE STANDARDS

A. National Electrical Manufacturers Association:

1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

B. NSF International:

1. NSF 61 - Drinking Water System Components - Health Effects.
2. NSF 372 - Drinking Water System Components - Lead Content.

1.3 COORDINATION

A. Coordinate Work of this Section with tank Work.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer information for system materials and component equipment, including connection requirements.

C. Shop Drawings:

1. Indicate system materials and component equipment.
2. Submit installation requirements and other details.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

G. Manufacturer Reports: Certify that equipment has been installed according to manufacturer instructions.

H. Qualifications Statement:

1. Submit qualifications for manufacturer.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for closeout procedures.

B. Project Record Documents: Record actual locations and final orientation of equipment and accessories.

1.6 QUALITY ASSURANCE

A. Ensure that materials of construction of wetted parts are compatible with process liquid.

B. Materials in Contact with Potable Water: Certified to NSF 61 and NSF 372.

C. Perform Work according to applicable standards.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three (3) years' documented experience.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store materials according to manufacturer instructions.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.9 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. Furnish three-year manufacturer's warranty for ultrasonic-level measurement devices.

PART 2 - PRODUCTS

2.1 ULTRASONIC-LEVEL MEASUREMENT DEVICES

A. Manufacturers:

1. ABB
2. Pulsar
3. Or Pre-Approved Equal

B. Description:

1. Measuring Range: Up to 35 feet
2. Operating Temperature Range: -40 to +170 ˚F
3. Operating Pressure: 10 to 36 psig

C. Operation: Menu guided.

D. Transmitters:

1. Selected by sensor manufacturer to match sensor.
2. Visual Display: Four digit.
3. Output Signal: Two (2) 4- to 20-mA dc analog signals for instantaneous level.
4. Location: As indicated on Drawings.
5. Control Power:

    a. 120-V ac, single phase, 60 Hz.
    b. Furnish local transformers as required.

6. Enclosures: NEMA 250 Type 4.
7. Mounting:

    a. Integral with sensor
    b. Wall

8. Furnish cable, field preamplifiers, and signal conditioners as required to maintain accuracy from sensor to terminal device.

2.2 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. Provide shop inspection and testing of completed assembly.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that items provided by other Sections of Work are ready to receive Work of this Section.

3.2 INSTALLATION

A. Coordinate location and orientation of level probe assemblies with final equipment installations.

B. Ensure that instruments are located to be easily accessible for maintenance.

3.3 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.

B. Manufacturer Services: Furnish services of manufacturer's representative experienced in installation of products furnished under this Section for not less than two (2) days on Site for installation, inspection, field testing, and instructing Owner's personnel in maintenance of equipment.

C. Equipment Acceptance:

1. Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.
2. Make final adjustments to equipment under direction of manufacturer's representative.

D. Furnish installation certificate from equipment manufacturer's representative attesting that equipment has been properly installed and is ready for startup and testing.

3.4 DEMONSTRATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION 40 72 13

SECTION 40 73 13 - PRESSURE AND DIFFERENTIAL PRESSURE GAUGES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Pressure gages.

B. Related Requirements:

1. Section 40 73 64 – Annular Pressure Seals: Isolation of gages from process fluid.

1.2 REFERENCE STANDARDS

A. ASME International:

1. ASME B40.100 - Pressure Gauges and Gauge Attachments.

B. NSF International:

1. NSF 61 - Drinking Water System Components - Health Effects.
2. NSF 372 - Drinking Water System Components - Lead Content.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer information for system materials and component equipment, including connection requirements.

C. Shop Drawings:

1. Indicate system materials and component equipment.
2. Submit installation requirements and other details.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations of equipment and accessories.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance materials.

B. Extra Stock Materials:

1. Gages: Furnish 20 percent spare gages, with a minimum of one gage for each range used.

1.6 QUALITY ASSURANCE

A. Ensure that materials of construction of wetted parts are compatible with process liquid.

B. Materials in Contact with Potable Water: Certified to NSF 61 and NSF 372.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store materials according to manufacturer instructions.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.8 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. Furnish one-year manufacturer's warranty for pressure gages.

PART 2 - PRODUCTS

2.1 PRESSURE GAGES

A. Manufacturers:

1. Ametek; Model Series 1550
2. Wika; Model Series 716
3. Ashcroft; Model Series 1010

B. Type: Differential - Compound.

C. Dials:

1. Nominal Diameter: 4 inches.
2. Face: White, laminated plastic dials with black graduations.
3. Scale: Extend over arc not less than 270 degrees.
4. Ranges and Graduation Units: As indicated on Instrument Schedule.

D. Cases:

1. Liquid filled.
2. Stainless Steel case and wetted parts.
3. Windows:

    a. Material: Clear, shatterproof glass.
    b. Thickness: 1/8 inch.
    c. Provide gasket.

E. Connection:

1. Location: Bottom.
2. Socket:

    a. 1/4-inch NPT male thread.
    b. Extend minimum 1-1/4 inches below gage cases.
    c. Provide wrench flats.

3. Mounting: Stem.

F. Measuring Element:

1. Bourdon Tubes:

    a. Material: Stainless steel to brass socket.
    b. Provide welded, stress-relieved joints.

2. Movement:

    a. Rotary.
    b. Material: Stainless steel.

3. Accuracy:

    a. Comply with ASME B40.100.
    b. ±0.5 percent of full-scale range.

G. Adjustment:

1. Provide for zero-reading adjustment.
2. Adjusting Screws: Accessible from rear of case without need for disassembly.

H. Accessories:

1. Shutoff Cocks: Furnished by gage manufacturer.

2.2 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. Provide shop inspection and testing of completed assembly.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that items provided by other Sections of Work are ready to receive Work of this Section.

3.2 INSTALLATION

A. According to manufacturer instructions.

B. Coordinate location and orientation of gages and seal assemblies with final piping and equipment installations.

C. Ensure that gages are located to be easily read during operation and easily accessible for maintenance.

3.3 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

B. Equipment Acceptance:

1. Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.
2. Make final adjustments to equipment under direction of manufacturer's representative.

3.4 DEMONSTRATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION 40 73 13

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 41 22 24 – ELECTRIFIED HOIST

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Electric hoists

1.2 SUBMITTALS

A. Product Data: Include capacities, sizes, performances, operations, safety features, finishes, and similar information.

B. Shop Drawings:

1. Include plans, elevations, sections, and large-scale details indicating attachment to existing and new structure.

C. Design Data:

1. Loading and sizing calculations

D. Test Data:

1. 125 percent rated load test
2. Post Erection Inspection
3. Load Chain Proof test

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For monorail hoist to include in emergency, operation, and maintenance manuals.

1. Submit manufacturer's standard operation and maintenance manual, according to ASME B30.16.

B. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted elevator use.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle materials, components, and equipment in manufacturer's protective packaging. Store materials, components, and equipment off of ground, under cover, and in a dry location.

1.5 COORDINATION

A. Coordinate installation of sleeves, block outs, and items that are embedded in concrete or masonry for monorail hoist equipment. Furnish templates and installation instructions and deliver to Project site in time for installation.

B. Coordinate locations and dimensions of other work specified in other Sections that relates to monorail hoist, including electrical service.

1.6 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace monorail hoist work that fails in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, operation or control system failure, including excessive malfunctions; performances below specified ratings; excessive wear; unusual deterioration or aging of materials or finishes; unsafe conditions; need for excessive maintenance; abnormal noise or vibration; and similar unusual, unexpected, and unsatisfactory conditions.
2. Warranty Period: Minimum one year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Coffing Model EC-10008

B. Or Approved Equal

2.2 ELECTRIFIED HOIST

A. Capacity: 5 tons

B. Horsepower: 3 hp

C. Electrical requirements: 480 V / 3 ph

D. Environment: Outdoors

E. Provide weatherproof cover for hoists.

2.3 CONTROLS

A. Provide pushbutton operator with raise/lower buttons.

B. Equip hoists with adjustable limit stops for chain to prevent over-travel in both the raising and lowering directions.

C. Hoist Load Brake: Provide hoist load brake that is capable of stopping and holding a 125 percent test load. If dynamic braking is not included, provide a hoist mechanical load brake that is capable of stopping and holding a 125 percent test load. If the hoist has more than one brake, each brake shall independently stop and hold 125 percent of rated capacity.

2.4 FINISHING

A. Provide manufacturer's standard painting system for outdoor service.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine hoist areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work. Verify critical dimensions and examine supporting structure and other conditions under which hoist work is to be installed.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install according to manufacturer’s instructions.

END OF SECTION 41 22 24

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 43 11 33 - ROTARY SCREW BLOWERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Rotary screw blowers and accessories.

B. Related Requirements:

1. Division 01 – General Requirements
2. Section 03 20 00 – Anchorage in Concrete
3. Division 26 - Electrical
4. Section 46 51 46 – Fine Bubble Diffusers

1.2 REFERENCE STANDARDS

A. American Bearing Manufacturers Association:

1. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

B. American Gear Manufacturers Association:

1. AGMA 6001 - Design and Selection of Components for Enclosed Gear Drives.
2. AGMA 6013 - Standard for Industrial Enclosed Gear Drives.
3. AGMA 6113 - Standard for Industrial Enclosed Gear Drives.

C. American Society of Mechanical Engineers:

1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.

D. National Electrical Manufacturers Association:

1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer information for blower, including accessories, curves with specified operating point plotted, power, rpm, sound power levels for both blower inlet and outlet at rated capacity, electrical characteristics, and connection requirements.

C. Shop Drawings: Indicate size and configuration of blower assembly, mountings, weights, and accessory connections.

D. Electrical schematics.

E. Manufacturer's Certificate: Certify that blowers meet or exceed specified requirements.

F. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

G. Source Quality-Control Submittals: Indicate results of shop tests and inspections.

H. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

I. Manufacturer Reports:

1. Certify that equipment has been installed according to manufacturer instructions.
2. Indicate activities on Site, adverse findings, and recommendations.

J. Qualifications Statement:

1. Submit qualifications for manufacturer.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for closeout procedures.

B. Project Record Documents: Record actual locations of blowers.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum 10 years' documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store blowers according to manufacturer instructions.

D. Protection:

1. Protect blowers and appurtenances from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.7 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

1.8 PERFORMANCE

A. The blowers shall be tested in the factory test laboratory standards to provide a baseline of performance, vibration and temperature readings. The testing must be performed at the manufacturer's facility. Outsourcing of testing procedures shall not be allowed. A certified test curve for each blower shall be provided to the engineer to verify compliance with all specified design criteria. Standard acceptance for the flow on the pressure curve is +/- 4%.

1.9 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. Furnish one-year manufacturer's warranty for blowers.

PART 2 - PRODUCTS

2.1 ROTARY LOBE BLOWERS

A. Manufacturers:

1. Gardner Denver / Hoffman
2. Or Pre-Approved Equal

B. General:

1. Blowers shall be factory pre-packaged screw type positive displacement blowers with electric motor drivers and base, in a sound/weather protection enclosure. Blower packages shall be complete with inlet air filter/silencer, inlet and outlet silencers, discharge unloading and pressure relieve valve, discharge check valve, discharge pressure gauge, and inlet vacuum gauge. Include all accessory items and integral control panels as described herein and as shown on the plans, which are required for proper operation of the blowers.

C. Performance and Design Criteria:

1. Number of blowers: 2
2. Design flow capacity per blower: 1500 SCFM
3. Discharge pressure: 8 psig
4. Elevation: 170 ft MSL
5. Motor horsepower: 75 hp
6. Discharge size: 8 in.
7. Service: Aerobic digester aeration
8. Mounting location: Outdoors

D. Blower:

1. High efficiency screw compressor to convey atmospheric air free of oil.
2. 3x5 helical screw rotor, and a high addendum patented profile, statically and dynamically balanced and manufactured in carbon steel C40 EN 10083/1 (ASTM A536 Grade 60-40-18), ground and PTFE coated against corrosion. Shafts integrated with the rotors built in steel C40 EN 10083/1.
3. Heavy duty shaft, with increased diameter for higher shaft load capacity, designed and tested for strength. Allows for direct drive or v-belt coupling.
4. Anti-friction bearings calculated to last over 100.000 h under maximum conditions of speed at 2.5barg (L10).
5. Helical timing gears, built in cement steel 16 Mn Cr 5, that provides smooth, quiet operation at all speed and ensures non-slip rotor timing.
6. O-rings used for all housing sealing. Provides premium protection against leaks and eliminates need for gaskets.
7. Air seals with piston rings with five rings on discharge end to minimize air leakage and to provide maximum seal life
8. Oil seals with "Inpro seals" contactless dual ring design. Non-wearing with extended life reducing maintenance costs. Market-leading protection against leaks
9. Dual splash lubrication of bearings on suction and discharge side and timing gear with eccentric slinger ring that provides efficient oil dispersion.
10. Maximum blower speed 3600rpm, for low speed, lower friction and high efficiency.
11. Highly resistant silicone painting

E. Base Frame and Discharge Silencer:

1. Compact base frame supporting both the blower and the electric motor, integrated with the discharge silencer and transmission belt-tensioning device, made in high strength steel plates.
2. Anti-vibration mounts capable of withstanding compression and shear loads with vibration damping level > 80%.
3. Discharge silencer consisting of diffusion and resonance sections providing a wide reduction range and without sound absorbing material in order to avoid contaminating the plant downstream to the compressor package. Maximum pressure losses 30 mbar (12 inches WC).

F. Closed Baseplate:

1. Made with transversal reinforcement with shape bars, with dedicated free forklift holes for easier installation, without open doors.
2. Baseplate powered coating: RAL 5003

G. Suction Silencer and Inlet Filter:

1. A compact suction silencer, consisting of a section based on absorption material for the reduction of the sound energy emitted at frequencies above 500 Hz.
2. Dedicated filter cartridge for improved reliability and quicker maintenance integrated with the inlet silencer.
3. Filtering element shall be placed downstream of the sound absorbing material of the inlet silencer to prevent any contamination of the conveyed air and protect the compressor.
4. Efficiency of the filtering element 93% on particles >= 10 micron.
5. Maximum pressure drop with new filtering element DP = 10 mbar (4" WC)
6. Maximum pressure drop with clogged filtering element DP = 25 mbar (10" WC)

H. Check Valve:

1. Single flap check valve on the outlet silencer to prevent the reverse rotation of the compressor when stopping.
2. Full section flow and low pressure loss
3. High strength rubber for maximum operating temperature T2 = 150°C (302F)

I. Relief Valve:

1. Direct acting spring loaded safety valve fitted on the outlet of the discharge silencer before the non-return valve in order to limit the differential pressure on the compressor.
2. Metal to metal seat seal surfaces (maintenance free)
3. Maximum settings pressure 1000 mbar (14.5 PSIG)
4. Maximum operating temperature 150 °C (302 F)
5. Dedicated box for exhaust the hot air directly outside the noise enclosure in case of valve opening.
6. Dedicated opening for a quick and easy inspection or setting mode.

J. Piping Connection:

1. The blower and silencers shall be directly connected to each other with flanges, without connecting pipes to reduce overall dimensions and pressure losses.
2. The valves shall be directly fitted onto the discharge silencer.
3. The blower shall have 8” discharge air pipe.
4. Connection to the system pipes shall be with flexible connectors fitted at the outlet nozzle of the discharge silencer to compensate the pipes thermal expansion and to reduce the vibration transmission.
5. Flexible connector shall be rubber reinforced with fabric inserts and suitable for operation up to 2 bar (29 PSIG) and temperatures up to 150°C (302F, held in position with pipe clamp straps.

K. Belt Drive and Guard

1. High efficiency belt with toothed profile and high adhesion.
2. Service factor > 1.4 on the power installed
3. Special device for adjustment of the belt that allows for its replacement while keeping the pulleys aligned
4. Non-sparking aluminum alloy belt guard assembly shall be provided.

L. Sound Enclosure

1. Blower shall have a sound enclosure to reduce noise levels <75 bBA.
2. All panels/doors shall be independent and easily removable for inspection.
3. Sound enclosure shall be weatherproof and suitable for outdoor installation. Materials shall be corrosion resistant in a wastewater environment.
4. Sound enclosure shall have sound-absorbing material consisting of open cell polyurethane foam thickness 50 mm with profiled finish, fire resistant according to ISO 3795 (MVSS TN 302).
5. A ventilation fan shall be provided for cooling the sound enclosure. The fan shall be sized for sufficient heat removal from the sound enclosure. The cooling fan shall be driven separately by a 120V, 1Ph, 60Hz electric motor powered by a separate 120V circuit as

indicated on electrical plans (to match the existing field wiring provisions). The enclosure shall be provided with a pre-wired thermostat to control the fan.

6. Enclosure air inlet and outlet duct shall be silenced with a lined single-chamber plenum and lined bends.
7. Double pipe for oil filling and external oil level sight gauges for checking oil level.

M. Motor

1. Asynchronous three phase, squirrel cage electric motor built according to NEMA standards.
2. EISA Certified
3. TEFC motor enclosure, Minimum protection grade IP 55.
4. 1.15 Service factor
5. 40C ambient
6. Class F insulation with Class B temperature rise
7. Drive side bearing to support the radial load induced by the V-belt transmission.

N. Instrumentation

1. Each blower shall be provided with the following instrumentation

    a. Discharge pressure gauge (glycerin filled)
    b. Vacuum gauge for measuring filter clogging.
    c. Temperature gauge

O. Electrical:

1. Voltage: 460 V, three phase, 60 Hz.
2. Furnish single point power connection and grounding lug.
3. Blowers are to be connected to the existing 75 hp VFDs.
4. Controller

    a. Factory mounted
    b. Provides control and monitoring of blower including, but not limited to operational data, alarms, warnings, run time, service indication, trends of measured values, and timer.

2.2 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. Furnish shop inspection and testing of each blower.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify layout, type, and orientation of piping connections.

C. Verify that items provided by other Sections of Work are ready to receive Work of this Section.

3.2 INSTALLATION

A. Installation Standards: Install Work according to manufacturer’s instructions.

3.3 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

B. Inspection: Inspect for proper operation of blowers.

C. Testing:

1. Test each blower minimum four hours at blower's rated capacity.

D. Manufacturer Services: Furnish services of manufacturer's representative experienced in installation of products furnished under this Section for not less than one (1) trips and three (2) days on site for installation, inspection, startup, field testing, and instructing Owner's personnel in maintenance of equipment.

E. Equipment Acceptance:

1. Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.
2. Make final adjustments to equipment under direction of manufacturer's representative.

F. Furnish installation certificate from equipment manufacturer's representative attesting that equipment has been properly installed and is ready for startup and testing.

3.4 ADJUSTING

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for starting and adjusting.

B. Check control functions and adjust as required.

3.5 DEMONSTRATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION 43 11 33

SECTION 43 22 10 – OPEN FLIGHT ARCHIMEDES SCREW PUMPS (ADDITIVE ALTERNATE NO. 1)

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Open flight Archimedes screw pumps

B. Related Requirements:

1. Division 01 – General Requirements
2. Section 03 20 00 – Anchorage in Concrete
3. Section 03 60 00 - Grouting

1.2 COORDINATION

A. Coordinate installation and startup of Work of this Section with plant operations.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit information concerning materials of construction, fabrication, and protective coatings.

C. Submit the following:

1. Shop drawings
2. Product literature
3. Complete description
4. Dimensions and required clearances
5. Weights and forces
6. Performance characteristics
7. Layout drawings for all equipment showing installation details
8. Materials of construction
9. List of all deviations from the drawings and specifications
10. Manufacturer’s warranty

D. Manufacturer's Certificate: Certify that pump and accessories meet or exceed specified requirements.

1. Certify installation is completed according to manufacturer's instructions.

E. Manufacturer's Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

F. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

G. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

H. Manufacturer Reports: Indicate that equipment has been installed according to manufacturer's instructions.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for closeout procedures.

B. Project Record Documents: Record actual locations and final orientation of equipment and accessories.

1.5 QUALITY ASSURANCE

A. The equipment manufacturer's shop welds and welding procedures shall be in accordance with the requirements of the latest edition of ANSI/AWS D1.1 "Structural Welding Code - Steel" published by the American Welding Society.

B. Manufacturer shall factory assemble equipment (as much as possible) to detect any defects and demonstrate that the equipment will function satisfactorily under all conditions specified.

1.6 TOOLS AND SPARE PARTS

A. The manufacturer shall provide one (1) set of recommended spare parts.

B. The manufacturer shall provide a list of recommended spare parts.

C. The manufacturer shall furnish any special tools necessary to disassemble, service, repair, and adjust the equipment.

1.7 EXISTING CONDITIONS

A. The Contractor shall field verify existing pump bay dimensions.

1.8 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. Furnish one-year manufacturer's warranty for pumps and components.

C. Lower bearing assembly shall be warranted for 5 years.

PART 2 - PRODUCTS

2.1 ARCHIMEDES SCREW PUMPS

A. Manufacturers:

1. Schreiber; Trussville, AL
2. Or Approved Equal

B. General

1. Provide one (1) open flight screw pump complete with spiral screw, upper stub shaft, upper bearing assembly, oil lubricated lower bearing assembly, flow deflection plates, gear reducer with backstop, flexible coupling, v-belts and sheaves, drive motor, and necessary anchorage.
2. Prior to the bid, the manufacturer shall review the contract drawings and specifications and advise of any conflicts with the layout and dimensions of the existing channel and bearing support pads or additional work required to install the equipment. No change orders will be given for failure to coordinate the requirements of new screw pumps installation in the existing channels and grout.

C. Performance and Design Criteria:

1.	Number of pumps	1
2.	Flow (per pump)	5,000 gpm
3.	Pumping lift	23.55 ft
4.	Pump diameter	54 in.
5.	Min. number of flights	3
6.	Min. flight thickness	0.25 in.
7.	Min. torque tube diameter	36 in.
8.	Torque tube wall thickness	0.375 in.
9.	Rotational speed	43 rpm
10.	Angle of inclination	38 degrees
11.	Motor horsepower	50

D. Details of Construction

1. Spiral Screw

a. Each spiral screw shall be fabricated of ASTM A 36 steel. Flights shall be helical shaped and continuously welded on both sides to the torque tube. All flight butt welds shall be full penetration joints.
b. Spiral deflection shall not be greater than 0.156”. Calculations for deflection and bearing loads shall be based on the dead weight of the screw plus the full weight of the liquid being pumped. Decreased loading from buoyancy effects shall not be considered in the design calculations. Stress shall be less than 2,800 psi.
c. The torque tube shall be sealed watertight with a welded steel plate at each end. All surfaces of the end plates mating with the bolted stub shafts shall be finish machined while the spiral is supported between centers in a lathe after welding to the torque tube and after all flight welding is complete to assure alignment.

d. The solid upper drive shaft and lower stub shaft shall be fitted with a machine faced gusseted steel plate flange shall be fastened to the fabricated spiral with ASTM A325 or Grade 8 high-strength bolts.
e. Each screw shall be placed in a lathe while the flights are trimmed to a true radius.
f. The completed spiral shall be statically and dynamically balanced.

2. Lower Bearing Assembly

a. The lower bearing assembly shall include a single row, combination radial and thrust, spherical roller bearing. It shall be capable of supporting the entire thrust load of the spiral and the lower radial load with a minimum calculated L-10 Life of 100,000 plus hours.
b. Contained in a fabricated steel housing, the lower bearing shall be oil lubricated, being maintained full of oil and slightly pressurized via tubing from a separate oil reservoir elevated above the maximum inlet level.
c. The separate elevated oil reservoir of ½ gallon capacity shall be transparent on the vertical side and visible at a distance of six feet to verify oil level.
d. An internal float switch with short external electrical leads shall be included to provide the capability for equipment shut down and/or remote alarm if the oil level is lowered sufficiently to close the switch. The float switch shall be provided with remote relay normally open with descending oil. This switch shall be wired into the motor starter control circuit to prevent the pump motor from operating in the event of low oil level.
e. Between the rotating member of the bearing housing attached to the pump spiral and the stationary member attached to the assembly base, there shall be a highly polished face seal to contain the oil in the housing and reject contaminants from the outside. A labyrinth arrangement between housing members shall protect the face seal from external debris in the liquid being pumped.

3. Upper Bearing Assembly

a. The upper stub shaft shall extend through a grease lubricated upper bearing assembly, which shall consist of a split housing fitted with single self-aligning bearing, upper and lower taconite seals.
b. All of the thrust load from the pump shall be carried by a spherical roller thrust-type lower bearing assembly and the upper screw pump radial load shall be carried by a spherical roller bearing.
c. The radial bearing shall be rated at a minimum of 100,000 hours AFBMA L-10 theoretical design life, based on the dead weight of the screw, plus the full weight of the liquid being pumped.
d. A split bearing housing shall be provided to allow removal of the cover for inspection of the bearings without removal of the stub shaft or the entire bearing assembly.

4. Drive Assembly

a. The drive assembly shall be designed and constructed for the maximum screw rotational speed. The drive assembly shall consist of a gear reducer with backstop, belts, sheaves, motor, and low speed coupling (except when using a shaft-mounted reducer, which does not require a low speed coupling).

b. Gear reducer shall be designed with a service factor of not less than 1.5 based on the torque requirements of the screw or 1.0 based on the motor horsepower, whichever is greater.
c. A visual oil level gauge and oil filler tube for the reducer shall be mounted on the reducer.
d. A backstop shall be provided with the reducer to prevent reverse rotation of the screw in the event power is interrupted.

5. Belts and Sheaves

a. Power transmission from the motor to the reducer shall be by means of a set of matched v-belts and sheaves, which shall be designed with a 1.5 service factor based on full motor horsepower.
b. Sheaves shall consist of a tapered shaft bushing with three (3) tapped holes to which the sheave is attached by three cap screws.
c. Belts and sheaves shall be covered with a safety guard in accordance with OSHA standards.

6. Motor

a. Motor shall be 460 volts, 3-phase, 60 Hertz, TEFC enclosure.
b. Motor mounting shall provide for easy adjustment to maintain proper v-belt tension.
c. Motor shall be provided with integral 120VAC condensation heaters to prevent corrosion.
d. Motor shall be provided with integral n.c. thermostats in windings (one per phase), to be monitored by the associated remote starter, to prevent overheating.

7. Deflector Plates

a. A flow deflector plate shall be provided to curve around the upper section on the uptake side of the screw to deflect the liquid as the screw rotates.
b. The flow deflector plate shall be fabricated of not less than 1/4 inch thick steel plate complete with stiffeners where required and stainless steel anchors on 2-foot centers at the bottom edge.
c. The deflector plate top edge shall have adjustable stainless steel anchors at not more than 8-foot centers.

8. Grouting

a. Equipment manufacturer shall furnish a radius screed for the Contractor to place the finishing grout in the trough with the screw after the unit has been installed.
b. Equipment manufacturer shall loan to the Contractor additional sheaves and belts as required to operate the screw at reduced speed for grouting the trough with the screw pump drive.
c. Grouting or sealing around deflector plates to be provided by the Contractor.

9. Anchor Bolts

a. Equipment manufacturer shall furnish all anchor bolts of ample size and strength required to securely anchor each item of equipment. Anchor bolts, hex nuts, and

washers shall be 304 stainless steel. Anchor bolts securing the lower bearing assembly shall be J-type embedded or L-type embedded.

b. Anchor bolts shall be set by the Contractor. Equipment shall be placed on the foundations, leveled, shimmed, bolted down, and grouted with a non-shrinking grout.

10. Painting

a. All motors, gear reducers, and bearing housings shall be coated with the respective manufacturer's standard finish coating.

b. Spiral, deflectors, and all fabricated items shall be sandblasted per SSPC-SP-10 to near white finish immediately followed by two (2) coats of coal tar epoxy with 7-10 mils DFT per coat.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify layout and orientation of pumps, accessories, and piping connections.

3.2 INSTALLATION

A. Install pumps and accessories where indicated on Drawings and according to manufacturer's instructions.

3.3 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

B. Equipment Acceptance:

1. Adjust, repair, modify, or replace system components that fail to perform as specified, and rerun tests.
2. Make final adjustments to equipment under direction of manufacturer's representative.
3. Document adjustments, repairs, and replacements in manufacturer's field services certification.

C. Manufacturer Services: Furnish services of manufacturer's representative experienced in installation of products furnished under this Section for not less than one (1) 8-hour days on-Site for installation, inspection, field testing, and instructing Owner's personnel in maintenance of equipment.

D. Furnish installation certificate from equipment manufacturer's representative attesting equipment has been properly installed and is ready for startup and testing.

3.4 DEMONSTRATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION 43 22 10

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 43 22 15 – TUBE MOUNTED ARCHIMEDES SCREW PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Tube mounted Archimedes screw pumps

B. Related Requirements:

1. Division 01 – General Requirements
2. Section 03 20 00 – Anchorage in Concrete

1.2 COORDINATION

A. Coordinate installation and startup of Work of this Section with plant operations.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit information concerning materials of construction, fabrication, and protective coatings.

C. Submit the following:

1. Shop drawings
2. Product literature
3. Complete description
4. Dimensions and required clearances
5. Weights and forces
6. Performance characteristics
7. Layout drawings for all equipment showing installation details
8. Materials of construction
9. List of all deviations from the drawings and specifications
10. Manufacturer’s warranty

D. Manufacturer's Certificate: Certify that pump and accessories meet or exceed specified requirements.

1. Certify installation is completed according to manufacturer's instructions.

E. Manufacturer's Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

F. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

G. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

H. Manufacturer Reports: Indicate that equipment has been installed according to manufacturer's instructions.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for closeout procedures.

B. Project Record Documents: Record actual locations and final orientation of equipment and accessories.

1.5 QUALITY ASSURANCE

A. The equipment manufacturer's shop welds and welding procedures shall be in accordance with the requirements of the latest edition of ANSI/AWS D1.1 "Structural Welding Code - Steel" published by the American Welding Society.

B. Manufacturer shall factory assemble equipment (as much as possible) to detect any defects and demonstrate that the equipment will function satisfactorily under all conditions specified.

1.6 TOOLS AND SPARE PARTS

A. The manufacturer shall provide one (1) set of recommended spare parts.

B. The manufacturer shall provide a list of recommended spare parts.

C. The manufacturer shall furnish any special tools necessary to disassemble, service, repair, and adjust the equipment.

1.7 EXISTING CONDITIONS

A. Contractor shall field verify dimensions of existing structure where new tube mounted screw pumps are to be installed.

1.8 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. Furnish one-year manufacturer's warranty for pumps and components.

C. Lower bearing assembly shall be guaranteed for 5 years.

PART 2 - PRODUCTS

2.1 ARCHIMEDES SCREW PUMPS

A. Manufacturers:

1. Schreiber; Trussville, AL
2. Or Approved Equal

B. General

1. Provide two (2) tube mounted screw pumps complete with a steel pipe support/conduit housing, an oil lubricated lower bearing assembly with oil reservoir, a spiral screw, and a drive assembly.
2. Prior to the bid, the manufacturer shall review the contract drawings and specifications and advise of any conflicts with the layout and dimensions of the existing channel and bearing support pads or additional work required to install the equipment. No change orders will be given for failure to coordinate the requirements of new screw pumps installation in the existing channels.

C. Performance and Design Criteria:

1.	Number of pumps	2
2.	Flow (per pump)	4,270 gpm
3.	Outer tube diameter	54 in
4.	Torque tube diameter	36 in
5.	Number of flights	3
6.	Angle of inclination	38 degrees
7.	Fill-to-threshold	10.42 feet
8.	Motor horsepower	25 hp

D. Details of Construction

1. Mechanical

a. The Support/Conduit Housing shall completely enclose the rotating spiral and provide bearing support at each end. The upper end shall include a shaft mounted gear box and drive and support/discharge chute weldment. The upper weldment shall also include angle lugs to provide lateral stability to an otherwise gravity, only, mounting of the pump assembly upon the concrete structure. The lower weldment shall be supported by chain from overhead support (existing). Direct attachment of the pump assembly to the support structure shall not be necessary.

b. The Lower Bearing Assembly shall be shop mounted to the end support weldment and the spiral end rim plate providing accurate alignment with the spiral axis. It shall be an oil lubricated design with a single row, combination radial and thrust spherical roller bearing and be capable of supporting the radial and all thrust loads with a minimum calculated rating of 100,000 L-10 life hours plus. The bearing housing shall be oil filled and slightly pressurized via tubing from an elevated

separate oil reservoir. A highly polished face seal between the rotating and stationary members of the bearing housing shall guard against oil leakage or contamination. Lip seals are not acceptable. A labyrinth arrangement between housing members shall protect the face seal from external debris in the liquid being pumped. Grease lubricated lower bearing will not be acceptable.

c. The Spiral Screw shall include a torque tube with welded on end plates and three (3) helical shaped flights continuously welded on both sides to the torque tube. All flight butt weld shall be full penetration joints. Minimum tube wall thickness shall be 3/8"; minimum flight thickness shall be 3/16". End plates shall be machined parallel, after welding, and the outside diameter of the flights trimmed in a lathe to ensure that the flights, torque tube, shafting and bearing share a common axis. The completed spiral shall be statically and dynamically balanced.
d. The separate elevated oil reservoir of ½ gallon capacity shall be transparent on the vertical side and visible at a distance of six feet to verify oil level. An internal float switch with short external electrical leads shall be included to provide the capability for equipment shut down and/or remote alarm if the oil level is lowered sufficiently to close the switch. The float switch will be provided with remote relay normally open with descending oil.
e. The upper bearing assembly shall be a self-aligning flange type through bearing. Seals shall be provided at each side of the housing to hold grease in and prevent external contaminants from entering. A grease fitting shall be conveniently located. Minimum calculated L-10 life shall be 100,000 hours.
f. The drive assembly shall consist of a shaft-mounted reducer, motor, v-belts, sheaves, and safety guard.

2. Electrical

a. Motor shall be 460 volts, 3-phase, 60 Hz, TEFC enclosure.
b. Motor anti-condensation heaters and/or overtemperature thermostats shall not be required by the manufacturer for this application (to coordinate with existing field wiring provisions).

3. Painting

a. All motors, gear motors, gear reducers, couplings, and bearing housings shall be coated with the respective manufacturer's standard machinery enamel.
b. Torque tube, flights, and interior of outer tube shall be sand blasted per SSPC-SP-10 to near white, followed by two (2) coats of Carboline 300M coal tar epoxy, 7-10 mils DFT per coat.
c. Outer shell and miscellaneous parts shall be sand blasted per SSPC-SP-6, followed by one (1) coat of Carboline #890, min. 6 mils DFT, color #0746 light gray, followed by one (1) finish coat of Carboline #134, min. 1.5 mils DFT, color # 0746 light gray.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify layout and orientation of pumps, accessories, and piping connections.

3.2 INSTALLATION

A. Install pumps and accessories where indicated on Drawings and according to manufacturer's instructions.

3.3 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

B. Equipment Acceptance:

1. Adjust, repair, modify, or replace system components that fail to perform as specified, and rerun tests.
2. Make final adjustments to equipment under direction of manufacturer's representative.
3. Document adjustments, repairs, and replacements in manufacturer's field services certification.

C. Manufacturer Services: Furnish services of manufacturer's representative experienced in installation of products furnished under this Section for not less than one (1) 8-hour days on-Site for installation, inspection, field testing, and instructing Owner's personnel in maintenance of equipment.

D. Furnish installation certificate from equipment manufacturer's representative attesting equipment has been properly installed and is ready for startup and testing.

3.4 DEMONSTRATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION 43 22 10

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 43 41 46 - POLYETHYLENE TANKS AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes polyethylene tanks for storage of the following chemicals:

1. Dilution Tanks

    a. Sodium Hypochlorite

2. Neat Tank

    a. Sodium Hypochlorite

B. Related Requirements:

1. Section 03 30 00 - Cast-In-Place Concrete.
2. Division 40 – Process Interconnections.
3. Division 43 – Process Gas and Liquid Handling, Purification, and Storage Equipment.
4. Section 46 33 83 - Liquid Chemical Feed Accessories

1.2 REFERENCE STANDARDS

A. American Society of Mechanical Engineers (ASME):

1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
2. ASME B16.42 - Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300.
3. RTP-1 – Reinforced Thermoset Plastic Corrosion Resistant Equipment.

B. America Society for Testing and Materials (ASTM):

1. D618 Conditioning Plastics and Electrical Insulating Materials for Testing
2. D638 Tensile Properties of Plastics
3. D790 Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
4. D883 Definitions of Terms Relating to Plastics
5. D1505 Density of Plastics by the Density-Gradient Technique
6. D1525 Test Method for Vicat Softening Temperature of Plastics
7. D1693 Test Method for Environmental Stress-Cracking of Ethylene Plastics
8. D1998 Standard Specification for Polyethylene Upright Storage Tanks
9. D2765 Degree of Crosslinking in Crosslinked Ethylene Plastics as Determined by Solvent Extraction
10. D2837 Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials
11. D3892 Practice for Packaging/Packing of Plastics
12. F412 Definitions of Terms Relating to Plastic Piping Systems

C. American Water Works Association (AWWA):

1. AWWA B300 – Hypochlorites

D. ARM (Association of Rotational Molders) Standards: Low Temperature Impact Resistance (Falling Dart Test Procedure)

E. ANSI Standards: B-16.5 Pipe Flanges and Flanged Fittings

F. OSHA Standards: 29 CFR 1910.106 Occupational Safety and Health Administration, Flammable and Combustible Liquids

G. UBC CODE: Latest Edition of the Uniform Building Code

H. IBC CODE: International Building Code 2018/2021 Edition

I. NSF/ANSI Standard 61 – Drinking Water System Components

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit information concerning materials of construction, fabrication, and protective coatings.

C. Shop Drawings: Submit detailed certified dimensional Shop Drawings showing tank size, layout of accessories, and anchoring system.

D. Manufacturer's Certificate:

1. Certify that products meet or exceed specified requirements.
2. Submit supporting documentation of Manufacturer’s certification to NSF/ANSI Standard 61
3. Certify that products are suitable for chemical usage in this application.
4. Submit certified list of tank installations, storing same chemical and concentration, in service for period of not less than five years.

E. Owner Installation Certificate: Obtain from equipment manufacturer's representative and submit, attesting equipment has been properly installed and is ready for startup and testing.

F. Delegated Design Submittals: Submit signed and sealed design calculations and assumptions for determination of shell thickness, nozzle reinforcement, and special elements of vessel construction and support.

G. Test and Evaluation Reports:

1. Submit certified data on physical properties of laminates being used to include laminate tensile modulus and flexural modulus in hoop and axial directions, and data on laminate makeup to include number and thickness of layers and layer glass content.
2. Submit certified factory test results.

H. Manufacturer's Instructions: Submit detailed instructions on installation requirements, including tank handling procedures, anchoring, and layout.

I. Source Quality-Control Submittals: Indicate results of shop/factory tests and inspections.

J. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

K. Manufacturer Reports: Submit certification after installation that tanks have been installed according to manufacturer's instructions.

L. Qualifications Statements:

1. Submit qualifications for manufacturer, installer, and licensed professional.
2. Submit manufacturer's approval of installer.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for closeout procedures.

B. Project Record Documents: Record actual locations and final orientation of tank and accessories.

C. Operation and Maintenance Data: Submit maintenance instructions for tank and accessories.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum ten (10) years' documented experience.

B. Installer: Company specializing in performing Work of this Section with minimum five (5) years of documented experience and approved by manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept tanks on-Site. Inspect tanks for damage.

C. Store products in areas protected from weather, moisture, or possible damage; do not store products directly on ground; handle products to prevent damage to interior or exterior surfaces.

1.7 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. The Contractor shall furnish a warranty extending twelve (12) months after substantial completion date.

C. The Manufacturer shall furnish a three (3) year warranty for replacement due to breakage, yellowing, abrasion, loss of light transmission, and coating delamination. Furnish three (3) year manufacturer's warranty on fittings and accessories supplied by the tank manufacturer.

PART 2 - PRODUCTS

2.1 TANKS

A. Manufacturers:

1. The equipment, polyethylene tanks, shall be manufactured by:

   a. PolyProcessing, Inc.
   b. Snyder Industries, Inc.
   c. Or Approved Equal.

B. Description:

1. This specification covers upright, cylindrical, flat bottom, single and double-walled tanks molded in a one-piece seamless construction by the rotational molding process (laminated or fabricated tanks will not be accepted). The tanks are designed for above-ground, vertical installation and are capable of containing chemicals at atmospheric pressure. Included are requirements for materials, properties, design, construction, dimensions, tolerances, workmanship, and appearance. Tank capacities are from 55 gallons up to 5400 gallons.
2. Use materials of construction to resist and retain process fluid without leakage or damage to structural integrity of tank; use same resin throughout construction of each tank.
3. Minimum thickness: 0.187 inch.
4. Vertical, non-sloping flat bottom; integral closed top.
5. Furnish liquid level gage sight glass, with flanges, indicating 10 - 90% of tank capacity.

C. Tank Designation

1. Dilution Tank #1 & #2
2. Neat Tank

D. Materials

1. Tanks shall be molded from high density cross-linked virgin polyethylene resin (Poly CL ™ or approved equal) and shall contain ultraviolet stabilizer as recommended by resin manufacturer. The resin shall have a carbon black compounded into it and shall be rotationally molded. The tank material shall be certified by the manufacturer.
2. Tank resin shall include an antioxidant polyethylene system with four times the antioxidant properties of a standard polyethylene bonded to the interior surface during the manufacturing process.

E. Design Criteria:

1. The minimum required wall thickness of the cylindrical shell at any fluid level shall be determined by the following equation, but shall not be less than 0.187 in. thick.

T = P x O.D./2 SD = 0.433 x S.G. x H x O.D./2 SD
T = wall thickness, in.
SD = hydrostatic design stress, PSI
P = pressure (.433 x S.G. x H), PSI
H = fluid head, ft.
S.G. = specific gravity, g/cm^3
O.D. = outside diameter, in.

a. The hydrostatic design stress shall be determined by multiplying the hydrostatic design basis, determined by ASTM D2837 using rotationally molded samples, with a service factor selected for the application. The hydrostatic design stress is 600 PSI at 73 degrees F. In accordance with the formula in 9.1, the tank shall have a stratiform (tapered wall thickness) wall.
b. The hydrostatic design stress shall be derated for service above 100 degrees Fahrenheit and for mechanical loading of the tank.
c. The standard design specific gravity shall be 1.5 or 1.9.

2. The minimum required wall thickness for the cylinder straight shell must be sufficient to support its own weight in an upright position without any external support.
3. The top head must be integrally molded with the cylinder shell. The minimum thickness of the top head shall be equal to the top of the straight wall. The top head of tanks with 2,000 or more gallons of capacity shall be designed to provide a minimum of 1,300 square inches of flat area for fitting locations.
4. Tanks with 2,000 or more gallons of capacity shall have a minimum of 3 lifting lugs integrally molded into the top head. The lifting lugs shall be designed to allow erection of an empty tank.
5. The tank shall be designed to provide a minimum of 4 tie-down lugs integrally molded into the top head. The tie-down lugs shall be designed to allow tank retention in seismic loading. Refer to section 2.4 for tank tie-down accessories.

2.2 NOZZLES AND ATTACHMENTS

A. Fittings - Threaded Bulkhead

1. Fittings shall be placed away from the tank knuckle radius' and flange lines. The maximum allowable size for bulkhead fittings placed on a curved sidewall section of tanks 48 in. to 142 in. in diameter is 2 inch size. Tank wall thickness must be considered for bulkhead fitting placement.
2. The bulkhead fittings shall be constructed of PVC or other specified material. Gaskets shall be a minimum of 1/4" thickness and constructed of 40-50 durometer EPDM, 60-70 durometer Viton, FKM, FMP or approved equal.

B. Fittings - Bolted Double 150 lb. Flange Fittings

1. Fittings must be placed away from tank knuckle radius' and flange lines.

a. The bolted double flange fittings shall allow tank wall thickness up to 2-1/2 in.

2. The bolted double flange fitting shall be constructed with 2 ea. 150 lb. flanges, 2 ea. 150 lb. flange gaskets, and the correct number and size of all-thread bolts for the flange specified by the flange manufacturer. The flanges shall be constructed of PVC Type I, Grade I, or other specified material. Gaskets shall be a minimum of 1/4" thickness and constructed of 40-50 durometer EPDM, 60-70 durometer Viton, FKM, FPM or approved equal. There shall be a minimum of 4 ea. full thread bolts. The bolts diameter is to meet ASNI standards based upon the flange size. The bolts may have gasketed flanged metal heads or bolt heads encapsulated in Type II polyethylene material. The encapsulated bolt shall be designed to prevent metal exposure to the liquid in the tank and prevent bolt rotation during installation. The polyethylene encapsulation shall fully encapsulate the bolt head. The polyethylene shall be color coded to distinguish bolt material (white - 316 S.S., yellow - Hastelloy C276, green - Titanium). Each encapsulated bolt shall have a gasket to provide a sealing surface against the inner flange.
3. Standard orientation of bolted double flange fittings shall have bolt holes straddling the principal centerline of the tank in accordance with ANSI/ASME B-16.5 unless otherwise specified.

C. Fittings - Bolted Stainless Steel Fittings

Fittings must be placed away from tank knuckle radius' and flange lines.

a. The bolted stainless steel fittings shall allow tank wall thickness up to 2 1/2 in.

2. The bolted stainless steel fittings shall be constructed with a minimum of 4 fully threaded 3/8 in. studs. Each fitting shall have one gasket and two flanges. The gasket shall be compressed between the inside of the tank wall surface and the inside flange of the fitting. The stainless steel fittings come standard with female x female pipe threads. The fittings shall be constructed of Type 316 stainless steel. Gaskets shall be a minimum of 1/4" thickness and constructed of 40-50 durometer EPDM, 60-70 durometer Viton, FKM, FPM, or approved equal.

D. Fittings - Molded Outlet

1. The outlet fitting shall be an integral part of the tank and provide complete drainage of liquid through the sidewall of a flat bottom container without the use of a special support structure or concrete pad.
2. The tank attachment shall be constructed from a PVC schedule 80 male adapter and is standard in 2,3,4 or 6 in. sizes on select tank sizes. This provides a schedule 80 pipe socket attachment (Except for the 6 in. size). Other outlet attachments are available in a variety of materials. The fitting orifice shall not be less than schedule 80 interior pipe size per ANSI B36.10-1979. O-rings shall be constructed of 70 +/- 5 durometer Viton, FKM, FPM, or approved equal. The inside diameter of the outlet is to be molded and is not to be drilled out to increase chemical flow.
3. On dual wall tank(s) greater than 1000 gallons, bottom fitting(s) must be designed to maintain 110% secondary containment integrity. Bottom containment fitting must include PTFE expansion joint designed to accommodate movement of primary tank in design accordance with ASTM-D 1998 tolerances. All secondary containment fittings and parts shall be resistant to chemical fume corrosion. Fitting shall include the option to connect a secondary containment pipe over primary pipe.

E. Fittings - Self-Aligning Threaded Bulkhead

1. Self-Aligning fittings are available for installation in vapor phase applications on curved surfaces depending on the spherical dome radius and the placement of the fitting on the tank dome. Fittings must be placed away from tank radiuses.
2. The self-aligning fittings shall be constructed of PVC or CPVC. Gaskets shall be a minimum of 1/4" thickness and constructed of 40-50 durometer EPDM, 60-70 durometer Viton, FKM, FPM, or approved equal.

F. Vents

1. Each tank must be properly vented for the type of material and flow rates expected. Vents must comply with OSHA 1910.106 (f) (2) (iii) or other accepted standard. All tanks must be vented for atmospheric pressure as well as any pressure created by filling and emptying the tank.
2. U-vents shall be supplied with mesh insect screening and sized accordingly based on manufacturer recommendation.
3. All U-vents shall be constructed of PVC or other specified materials.
4. When a tank is being filled from a pressurized tanker truck steps shall to be taken to avoid pressurizing the tank. The tank may require a secondary surge protection lid to avoid any pressure build up. The surge protection lid is to be a 14” or 18” hinged and be design that it is self-closing.

G. Flange Adapters

1. Flange adapters may be required to adapt threaded or socket fitting outlets to 150 lb. flange connections for connection to piping system components. Flange adapter construction shall utilize schedule 80 components in sizes ranging from ¾” to 8” depending on material required.

H. Flexible Connections

1. All tank fitting attachments shall be equipped with flexible couplers or other movement provisions. Tank piping flexible couplers shall be designed to allow 4% design movement. Movement shall be considered to occur both outward in tank radius and downward in fitting elevation from the neutral tank fitting placement.
2. The flexible connection shall be manufactured of the same material as the tank or a compatible material. If an elastomer flexible connection is used control bolts are required if recommended by the manufacturer. The flexible connection shall be designed for a minimum of 4% movement. The flexible connection is to be designed with 150# flange connections to allow for attachment to the tank and the piping system. The flexible connection shall be attached as close as possible to the tank to reduce stress.

2.3 INSULATION REQUIREMENTS:

A. The designated storage tank walls and tops shall be insulated with 2 inches of polyurethane foam insulation (density 2 to 3 #/ft^3), U factor of 0.086 BTU per hour per square foot per degree Fahrenheit which shall be protected by a 100-mil layer of resin and chopped fiberglass or latex mastic and an exterior pigmented white gel coat surface. The insulation cover shall be highly resistant to ultra violet radiation.

2.4 ACCESSORIES

A. Reverse Level Indicators

1. Furnish and install liquid level indicators on the exterior of the indicated storage tanks. The level indicator shall be actuated by a float within the tank through a polypropylene tape with high visibility numbers in feet and inches to a weighted indicator on a pulley system. All wetted parts, parts subject to condensation or exposure to the atmosphere within the tank shall be suitable non-corrosive durable material approved by the Engineer. The indicator board shall be marked in ten-gallon increments and labeled every fifty gallons. All moving parts shall be vapor tight fully enclosed but easily accessible for maintenance. The indicator shall utilize the 3" top opening in the tank and shall be mounted on the side wall of the tank with appropriate anchor materials.

B. Fill Stations

1. A permanent fill station shall be constructed as shown on the drawings and shall be fitted with quick couplers. Quick Coupler Adaptors and caps for making quick connections shall be Kamlok 633A and 634B, respectively or equal. Couplers for Sodium Hypochlorite shall be titanium.

C. Manway and Fill Cap

1. Manways shall be 24-in. diameter or greater and equipped with a manufacturer recommended combined manway and vent to prevent over pressurization of tank. Manway must be capable of relieving a volume flow rate of up to 2650 ACFM. Gaskets shall be closed cell cross-linked polyethylene foam, viton or EPDM materials.

D. Down Pipes and Fill Pipes

1. Down pipes and fill pipes shall be prepared per the drawings. All down pipes and fill pipes shall be supported at 5 ft. maximum intervals with support structures. Standard support structure design shall utilize bulkhead fitting tank attachments or welded attachments on Type II tanks.
2. All down pipes and fill pipes shall be constructed of PVC or other specified materials.

E. Tank Attachments – External Fill Pipes

1. External fill pipes shall be prepared per the drawings and specifications. All external fill pipes shall be supported at 3 ft. maximum intervals with a support structure independent of the tank (ground supported).
2. All external fill pipes shall be constructed of PVC or other specified materials.

F. Ladders

1. Ladders shall be constructed of FRP.
2. Safety cages are not needed, unless required by OSHA standards.
3. All ladders shall be designed to meet applicable OSHA standards. Reference: OSHA 2206; 1910.27; fixed ladders.
4. Ladders shall be mounted to the tank to allow for tank expansion and contraction due to temperature and loading changes. All top ladder mounts shall be connected to integrally

molded-in attachment lugs that allow for tank movement due to temperature and loading changes.

G. Tie Down Systems

1. The tie down system shall be designed to withstand 150 mph wind loads. Tie down systems must meet seismic requirements per the most recent IBC/CBC code with seismic loads ≤ .445g (Seismic Design Category "D" - Fa=1.0, Fv=1.5, Ss=1.4, S1=0.5). Anchor bolts shall be provided by the Contractor per the calculations and the base plates for the system.
2. The tie down system shall be 304 stainless steel.

H. Tank Nameplate

1. Mark each tank with encapsulated paper tag or stainless-steel nameplate not less than 4 by 6 inches in size; attach to outside of tank wall.
2. Print the following information on nameplates:

a. Name of manufacturer.
b. Capacity (in gallons).
c. Height.
d. Diameter.
e. Service.
f. Manufacturer serial number.
g. Year built.
h. Maximum specific gravity.
i. Pressure and temperature rating.
j. Resin.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify layout and orientation of tank accessories and piping connections.

3.2 PREPARATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.

B. Thoroughly clean chemical storage tank pad, removing loose concrete, dust, and other debris. Place two layers of building paper on pad according to tank manufacturer's recommendations prior to placing tank.

3.3 INSTALLATION

A. Install chemical storage tank as indicated on Drawings and according to manufacturer's instructions.

B. Connect piping to tank.

C. Install tank accessories not factory mounted to complete installation.

3.4 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.

B. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

C. Field Testing:

1. Hydrostatically test each chemical storage tank by filling with water to the overflow pipe level.
2. Conduct test minimum of 48 hours.
3. No leakage permitted.
4. Adjust, repair, modify, or replace components of system failing to perform as specified, and rerun tests.

D. Furnish services of manufacturer's representative experienced in installation of products supplied for not less than two, eight-hour days on-Site for installation inspection, field testing, and instructing Owner's personnel in maintenance of equipment.

E. Obtain Installation Certificate from equipment manufacturer's representative attesting equipment has been properly installed and is ready for startup and testing, and furnish to Owner.

3.5 ATTACHMENTS

A. Polyethylene Storage Tank Schedule:

1. Neat Tank

a. Material Stored: Sodium Hypochlorite (12%)
b. Chemical Specific Gravity: 1.174
c. Configuration: Vertical Double Wall Tank
d. Dimensions: 143”Ø x 116.5” nom
e. Capacity: 5,400 gal
f. Insulated: Yes
g. Heat Trace: No
h. Tank Material: HDLPE or XLPE
i. Fitting Material: PVC
j. Gasket Material: Viton, FKM, FPM, or approved equal
k. Bolt Material: Titanium

l. Color: Natural
m. Accessories: Reverse Level Gauge, Down Pipes and Fill Pipes, External Fill Pipes, Ladder, Manway, Tank Nameplate, and Restraint System with titanium anchors, cables, and hardware.
n. Fittings:

1) 1 – 4" vent with screen
2) 1 – 3" nozzle, top mounted for reverse level indicator
3) 1 – 2" nozzle, top mounted, for fill
4) 1 – 2" nozzle, top mounted, for level transducer
5) 1 – 2" overflow positioned above the volume elevation
6) 1 – 2" product outlet
7) 1 – 24" ID manway in top

2. Dilution Tank #1 & #2

a. Material Stored: Sodium Hypochlorite (6%)
b. Chemical Specific Gravity: 1.091
c. Configuration: Vertical Double Wall Tank
d. Dimensions: 143"Ø x 116.5" nom
e. Capacity: 5,400 gal
f. Insulated: Yes
g. Heat Trace: No
h. Tank Material: HDLPE or XLPE
i. Fitting Material: PVC
j. Gasket Material: Viton, FKM, FPM, or approved equal
k. Bolt Material: Titanium
l. Color: Natural
m. Accessories: Reverse Level Gauge, Down Pipes and Fill Pipes, External Fill Pipes, Ladder, Manway, Tank Nameplate, and Restraint System with titanium anchors, cables, and hardware.
n. Fittings:

1) 1 – 4" vent with screen
2) 1 – 3" nozzle, top mounted for reverse level indicator
3) 1 – 2" nozzle, top mounted, for fill
4) 1 – 2" nozzle, top mounted, for level transducer
5) 1 – 2" overflow positioned above the volume elevation
6) 1 – 2" product outlet
7) 1 – 24" ID manway in top

END OF SECTION 43 41 46

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 46 05 53 - IDENTIFICATION FOR WATER AND WASTEWATER EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Nameplates.
2. Tags.
3. Stencils.
4. Labels.
5. Lockout devices.

1.2 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturers catalog literature for each product required.

C. Shop Drawings: Submit list of wording, symbols, letter size, and color coding for equipment identification and schedule, including equipment number, location, function, and manufacturer's name and model number.

D. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.

E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

PART 2 - PRODUCTS

2.1 NAMEPLATES

A. Description: Laminated three-layer plastic with engraved black letters on light, contrasting background color.

2.2 TAGS

A. Metal Tags:

a. Stainless steel construction; stamped letters.
b. Minimum Tag Size and Configuration: 1 inch x 2-inch (minimum) with finished edges.

2.3 STENCILS

A. Description:

1. Clean-cut symbols.
2. Letter Height**:** 1-3/4 inch.

B. Stencil Paint: As specified in Section 09 90 00 - Painting and Coating; semi-gloss enamel.

2.4 LABELS

A. Description:

1. Laminated Mylar construction.
2. Minimum Size: 1.9 by 0.75 inch.
3. Adhesive backed, with printed identification.

2.5 LOCKOUT DEVICES

A. Lockout Hasps:

a. Anodized aluminum construction.
b. Furnish hasp with erasable label surface.
c. Minimum Size: 7-1/4 by 3 inches.

PART 3 - EXECUTION

3.1 PREPARATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.

B. Degrease and clean surfaces to receive adhesive for identification materials.

C. Prepare surfaces as specified in Section 09 90 00 - Painting and Coating for stencil painting.

3.2 INSTALLATION

A. Identify equipment with nameplates.

B. Identify inline pumps and other small devices with tags.

C. Identify control panels and major control components outside panels with plastic nameplates.

D. Apply stencil painting as specified in Section 09 90 00 - Painting and Coating.

E. Install identifying devices after completion of coverings and painting.

F. Install plastic nameplates with corrosion-resistant mechanical fasteners or adhesive.

G. Labels:

1. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer.
2. For unfinished covering, apply paint primer before applying labels.

H. Install tags using corrosion-resistant chain.

END OF SECTION 46 05 53

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 46 21 15 – MECHANICAL SCREEN AND COMPACTING EQUIPMENT

1.1 SUMMARY

A. Section Includes:

1. Front-cleaning, front-return link-driven mechanically cleaned bar screen.
2. Screenings washer/compactor

B. Related Requirements:

1. Division 01 – General Requirements
2. Section 03 20 00 – Anchorage in Concrete
3. Division 26 - Electrical
4. Division 40 – Process Interconnections
5. Section 46 21 73 – Screenings Washing and Compacting Equipment

1.2 DEFINITIONS

A. UHMWPE: Ultra-high molecular-weight polyethylene.

1.3 REFERENCE STANDARDS

A. ASTM International:

1. ASTM A320 - Standard Specification for Alloy-Steel and Stainless-Steel Bolting for Low-Temperature Service.

B. American National Standards Institute (ANSI)

C. American Society for Testing and Materials (ASTM)

D. American Welding Society (AWS)

E. American Institute of Steel Construction (AISC)

F. American Bearing Manufacturers Association (ABMA)

G. American Gear Manufacturers Association (AGMA)

H. National Electrical Manufacturers Association:

1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

I. Underwriters Laboratory (UL)

J. National Fire Prevention Association (NFPA)

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer information for system materials and component equipment, including performance characteristics.

C. Shop Drawings:

1. Indicate system materials and component equipment, including detailed wiring and control diagrams.
2. Indicate complete information concerning fabrication, installation, anchoring, fasteners, and other details.
3. Indicate component materials, connections, and supports.

D. Electrical

1. Control panel drawings, wiring diagrams and control narrative.

E. Manufacturer's Certificate:

1. Certify that screening equipment meets or exceeds specified requirements.
2. Certify that installation is completed according to manufacturer instructions and that screens have been properly installed and tested and are ready for operation.

F. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures, anchoring, and layout.

G. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

H. Qualifications Statements:

1. Submit qualifications for manufacturer, installer, and licensed professional.
2. Submit manufacturer's approval of installer.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations and final orientation of equipment and accessories.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance materials.

B. Spare Parts:

1. Furnish **one (1) set** of manufacturer's recommended spare parts.

C. Tools: Furnish special tools and other devices required for Owner to maintain screening components.

1.7 QUALITY ASSURANCE

A. The screens and washer compactors shall be fully assembled and shop tested at the manufacturing facility prior to shipment.

B. All equipment specified in this Section shall be supplied by a single manufacturer. The manufacturer shall have at least 50 installations of link driven mechanically cleaned bar screens and washer compactors that has been in successful operation, in similar installations, for at least ten (10) years.

C. Screen(s) shall be Manufacturer’s standard product and only modified as necessary to comply with the Drawings, Specifications, and specified service conditions.

D. All welding is performed in accordance with American Welding Society (AWS) D1.1 Structural Welding Code, or equivalent.

E. The equipment specified herein shall have operations, origin of manufacture, after sales service and support in the United States.

F. Manufacturer shall provide screen, motors, gear reducers, controls, control panels, and lifting attachments as a complete integrated package to ensure proper coordination, compatibility, and operation of the system.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. The screening system shall be appropriately crated and delivered to protect against damage during shipment.

C. Inspection: Accept materials on Site in original packaging and inspect for damage.

D. Store screen and components according to manufacturer instructions.

E. Protect screen and components from water and wet weather.

1.9 EXISTING CONDITIONS

1. The Contractor shall field verify existing screen channel dimensions.

1.10 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. Manufacturer shall provide a written one (1) year standard warranty from the date of use of the mechanical screen and washing/compacting equipment to guarantee that there shall be no defects in material or workmanship in any item supplied.

C. Manufacturer shall warrant for the period of five (5) years all rotating parts of the mechanically cleaned bar screen including the gear motor, bearing, drive head, and the link system including the links, castings, pins and retaining rings. Manufacturer warrants that these components shall be replaced if damaged or defective in the normal use of the equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The equipment shall be manufactured by:

1. Duperon
2. Huber
3. Or Pre-Approved Equal

a. Specifications and equipment arrangements for the screening equipment are based on Duperon. Changes to the arrangement indicated in the specifications and in the plan set shall be at the expense of the installing contractor. No change orders will be issued to the contractor for modifications to the laying length, footprint, concrete layout, electrical, mechanical, etc.

2.2 MECHANICAL SCREEN

A. General

1. Type: Front-cleaned, front return link driven mechanically cleaned bar screen
2. Screen shall automatically discharge screenings into screenings washer compactor.
3. The screen shall have a head sprocket only, with no sprockets, bearings, idlers, or similar drive components under water to trap the chain. Equipment featuring reciprocating rake arms or lower bearings/sprockets/tracks below the water is not acceptable.
4. The entire bar screen shall be cleaned a minimum of every 7.1 seconds at high speed.
5. The screen shall be designed to run continuously (24/7) without operator intervention.
6. The equipment shall have multiple scrapers on the bar screen at one time cleaning continuously from bottom to top, the entire width of the bar screen. The drive output shaft rotation shall be constant and in one direction in order to reduce maintenance and increase product life. Units which have single raking arms or that require cycle times shall not be allowed. Cleaning mechanisms that use shock absorbers, springs or other dampening or hydraulic actuations are unacceptable.

7. The link system shall have jam evasion capability by flexing around and collecting large objects and surges of solids at peak loading times without overloading and shutting down the unit. The link system shall be such that it bends in one direction only, which allows it to become its own lower sprocket and frame and shall have a 1,000-pound lifting capacity. Designs employing the use of endless moving media or cables and hydraulic cylinders to remove debris from the channel and units using proximity or limit switches for reverse cycles are not acceptable.
8. The design shall be such to ensure that all maintenance can be accomplished at the operating floor level or above. No part of the drive system including sprockets shall be located below the water surface.

B. Performance and Design Criteria:

1.	Number of Screens:	1
2.	Peak Flow per screen:	6.20 MGD
3.	Average flow to screen:	2.50 MGD
4.	Bar opening size:	0.25 in.
5.	Channel width:	3 ft.
6.	Channel height:	6 ft.
7.	Angle of inclination:	30 deg.
8.	Velocity through grid at 30% blinding:	4.99 ft/s
9.	Headloss at 30% blinding	3.7 in.
10.	Screen motor horsepower:	1 hp (max)
11.	Equipment environment:	Outdoors

C. Components

1. Bar Screen Assembly

   a. Bar screen assembly shall be constructed of stainless steel.
   b. A stainless steel channel bottom plate shall be an integral part of the bar screen assembly to fully engage scrapers in the bar screen at the base of the unit and assure that the raking mechanism reaches the bottom of the screen to prevent debris accumulation.

      1) Screen Bars: Bars shall be 316L stainless steel and be tear-shaped with a hydraulic coefficient shape factor of 0.76 and the minimum dimensions of 0.25 inch x 0.75 inch x 0.13 inch. Bars shall be individually replaceable without welding.
      2) Side Fabrication: The screen framework shall be 304 stainless steel bent plate with minimum of 3/16 inch cross section. Horizontal members shall be of stainless steel bent plate or stainless steel pipe. Support members and frame shall adequately support the bar screen based on site-specific requirements.
      3) Dead Plate: Dead plate shall be minimum 0.15 inch thick 304 stainless steel. The dead plate shall be flat and true; span the entire width of the unit; and transition from bar screen to discharge point.
      4) Discharge Chute: The discharge chute shall be 11-gauge, 304 stainless steel. The discharge chute shall be bolted to the dead plate and shall be designed to allow debris to be transferred from discharge point into the debris containment.

5) Link Slides: Link slide assembly shall be provided per manufacturer standard design and shall be constructed of UV Stable UHMW PE and 304 stainless steel supports and components.

2. Return Guide/Closeouts

   a. Return guide/closeouts shall be 304 stainless steel and shall assure proper alignment of scrapers as they enter the bar screen and assure that there is no space wider than the clear opening between bars to prevent passage of larger solids than allowed through the screen.

3. Debris Blade Debris Blade

   a. A 304 stainless steel and UV Stable UHMW-PE debris blade assembly, which shall not require a separate drive, shall be installed to assist in removing debris from the scraper on the mechanically cleaned bar screen unit as recommended by the manufacturer.

4. Screen Enclosure

   a. A 304 stainless steel enclosure shall be installed to cover the screen above the operating deck level. Front enclosure shall have removable panels for access to equipment. Removable panels shall be 304 stainless steel and shall be provided with a lift off option for "no tool required" access. Rear Enclosure shall have hinged removable doors and shall be secured with a magnetic latch.

5. Link System

   a. The link system shall be passivated stainless steel castings and have a minimum ultimate strength of 60,000 pounds. with a minimum cross section of 1.5 inches and weighing a minimum of 5 pounds each. Parts must meet ASTM A380 specification for surface finish.
   b. Link bearing shall be SAE 841 Bronze type for unlimited life. All wear shall happen between the pin and bearing surface.

6. Scrapers

   a. Scrapers shall be spaced 24 inches apart max. To provide long product life the scraper shall move at no greater than 34 inches per minute at normal operating speed allowing for approximately 1.41 debris discharges per minute.
   b. Scrapers shall be minimum 0.25 inch thick x 4.2 inches x screen width stainless steel.

7. Drive Head

   a. The drive head shall be located at the top of the screen.
   b. Drive sprockets and drive shaft shall be 304 stainless steel.
   c. The gearbox shall be shaft-mounted, right angle type and include spiral bevel gearing. The output shaft speed shall be controlled by a vector type inverter. It shall have at least a 1.15 or greater service factor based on machine torque requirements.

The gearbox shall not be vented to the outside atmosphere. The gearbox shall be grease filled.

d. All drive head components shall be of components available in the United States.
e. Bearing shall be a non-lubricated no maintenance engineered polymer or ball or roller bearings. Bearings containing grease are not acceptable.
f. Speed reducer shall be a double-reduction, cycloidal or bevel gear style and shall comply with all applicable AGMA standards.

8. Motor

a. The motor shall be AC induction type, inverter duty, and mounted to the gear reducer. The motor shall be 1 HP, and rated for Class I, Groups C & D, and NEMA design B. Service factor shall be 1.0 or greater with Class F insulation. The motor shall be UL listed and designed for continuous operation.
b. The motor shall have a built in, normally closed, thermostat to protect from overheating that is to be field wired to corresponding terminals in the Main Control Panel for overload protection.

9. Coating

a. All non-stainless bar screen components shall be coated in strict accordance with the paint manufacturer's specification. Surface preparation shall be done in accordance with SSPC-SP-10 near-white. The three-part coating system shall be manufactured by Tnemec as follows:

1) Prime Coat: Series 90-97 Tneme Zinc at 2.5-3.5 mils DFT
2) Intermediate Coat: Series 27 F.C. Typoxy at 3.0-5.0 mils DFT
3) Top Coat: Series 1095 Endura-Shield at 2.0-3.0 mils DFT.

10. Instrumentation

a. Two (2) float switches shall be provided by the manufacturer to control the operation of the screen (two level / two speed control).

2.3 SCREENINGS WASHER COMPACTOR

A. General:

1. Screenings washer/compactor shall wash out organics and dewater screenings in an automatic sequence.
2. Compacting action: The washer compactor shall have dual augers to provide positive displacement action. Augers shall be oriented on top of each other and rotate in opposing directions. Augers shall be intermeshed, with one left-hand and one right-hand lead. Augers shall be designed with a limited float on top of a strainer to allow for the accommodation of irregular debris.
3. Washing action: The washer compactor shall have a wash water manifold integrated into the main housing. Two ports inside the unit shall emit a medium pressure stream. Wash water shall run continuously when the washer compactor is in motion.

B. Operation

1. The washer compactor shall be continuous run, not requiring an operator. The washer compactor shall be equipped with a self-regulating, active pressure zone designed to accept non- standard wastewater debris in its original form, including but not limited to: rocks; broken concrete; and metal (such as bolts or short pipe) up to 4 inches long. The washer compactor shall have the ability to process multiple pieces of clothing, variable volumes of debris, and unprocessed septage or grease. The washer compactor shall move at a normal operating speed of 0.5 to 2.2 RPM and shall have the ability to run intermittently to sync with upstream equipment.

C. Design Requirements

1. Number of units: 1
2. Peak Capacity: 30 ft^3/hr
3. Average capacity (continuous): 6.5 ft^3/hr
4. Wash water requirements: 10 gpm (max) @ 40 – 60 psi
5. Mass/weight reduction: 60 – 70%
6. Volume reduction: 70 – 80%
7. Motor size: 1 hp

D. Components

1. Main Housing

   a. The main housing shall be constructed of stainless steel with a minimum thickness of 11 gauge. Support and flange connections shall be 3/8 inch.

2. Hopper

   a. The hopper shall be constructed of stainless steel with a minimum thickness of 11 gauge.

3. Augers

   a. The augers shall be of stainless steel with 8 inch diameter flights, 3/8 inch thick, with 4 inch flight pitch.
   b. The augers shall be coupled to a transmission at the drive end and be supported at the compaction end with UHMW plane bearings. This arrangement shall allow for the accommodation of irregular debris.
   c. The auger shaft shall be 2 inch stainless steel schedule 40 pipe with 2 inch solid stainless steel stub shaft.

4. Compaction Housing

   a. The compaction housing of the Washer Compactor shall be ¼ inch stainless steel and shall house a spring and gate assembly to provide the resistance for compaction. The compaction housing shall contain the auger supports.

5. Discharge Chute

a. The discharge chute shall be constructed of stainless steel with a minimum thickness of 14 gauge. Support and flange connections shall be 1/4 inch. The discharge chute shall be tapered outward toward the discharge end.
b. Discharge chute shall be routed to the existing dumpster. The chute orientation shown on the drawings is approximate and shall be field verified by the Contractor.
c. Manufacturer shall provide all supports as required.

6. Wash Water

a. The wash water shall connect to the washer compactor at a single point with a ½ inch NPT female connector. A solenoid valve shall be provided (by manufacturer) to limit the wash water flow to only when the washer compactor is running. Ball valves shall be provided to distribute flow to the washing and trough sprayer connections.

7. Strainer

a. A strainer shall be located beneath the lower auger to filter the washed solids. The strainer shall be removable via drain trough and pressed against the lower auger with spring pressure. The strainer shall be self-cleaning through continuous, even contact with the lower auger.

8. Drain Trough

a. A removable pan shall be provided beneath the main housing to collect washwater. Washwater shall be drained through a 3 inch NPT male drain port and directed back into the screen channel. The pan shall be a minimum of 11 gauge stainless steel.

9. Drive Assembly

a. The gearbox shall be greased, lubricated, and designed for 5 years (or 20,000 hours) of operation between recommended clean and re-grease services. The gearbox shall be right angle type, and shall incorporate cycloidal and spiral bevel gearing with a total ratio of 809:1. The gear reducer output shaft speed shall be 0.5 RPM minimum to 2.2 RPM maximum and controlled by a vector-type inverter (or greater service factor) based on unit torque requirements. It shall be shaft-mounted utilizing the keyless Taper-Grip® bushing.
b. The motor shall be mounted to the gear reducer by utilizing a quill, C-Face mounting style.
c. The drive assembly shall incorporate the Duperon standard coating system.

10. Motor

a. The motor shall be 1 hp, AC induction type, 460 V, explosion proof, inverter duty rated.

11. Auger Transmission

a. The drive assembly shall be coupled to a dual gear transmission, which drives the augers in a counter-rotation.

b. The spur gears shall be contained in a stainless steel housing and supported by Delrin (or equivalent) plane bearing.
c. Grease fittings shall be located outside of the transmission housing to provide lubrication to the gears.

12. Speed Reducer

a. The speed reducer shall have a maximum output of 2.2 RPM, 809:1 reduction ratio with 18,900 in-lb. of output torque.

13. Thrust Bearings

a. Thrust bearings shall be Delrin (or equivalent), self-lubricating, and be capable of withstanding a minimum of 2000 lb. of thrust load (each auger) at 2.2 RPM for life of machine.

14. Screw Supports

a. Screw supports shall be UHWM plane type, self-lubricating, and fastened into place using stainless steel fasteners.

2.4 ELECTRICAL

A. General:

1. One (1) main control panel shall be provided to control all of the equipment provided in this section (screen and compactor). The manufacturer shall be responsible for proper sizing and function of the controls for a site supply voltage of 480V, unless specified otherwise.
2. Refer to Specification Section 26 29 00 - Manufactured Control Panels for additional control panel requirements.
3. Control panel shall have a stainless steel enclosure.
4. The manufacturer shall be responsible for the proper sizing and function of the controls.
5. Control panel location: Outdoors at the headworks
6. Control panel shall be 480V and include a step-down transformer as needed for 120V controls.
7. Control panel shall be NEMA 4X, UL certified, and shall be supported by appropriate UL labeling.
8. Control panel shall include a main, lockable disconnect.
9. Controls shall be tested prior to shipment. The manufacturer shall verify all overload settings in the rake controller to ensure proper overload and speed settings required for the application are properly programmed.
10. Control panel shall be wired complete with a minimum of #16 MTW wire in the appropriate colors for the circuits being supplied. 120VAC control shall be red, grounded AC neutral shall be white, DC control shall be blue, DC neutral shall be white with blue tracer, equipment ground shall be green and all incoming and outgoing external power source wires shall be a yellow configuration. All AC power wiring shall be a minimum of #12 Black. All wires shall be labeled at both ends with heat-shrink wire markers. Internal panel wiring shall be contained in non-flammable, covered wire way.

11. All panel(s) and panel mounted devices shall be labeled with engraved I.D. markers that reference back to the system schematics. Tags shall be white with black core, engraved as required.
12. All field wiring and power cables between the bar screen's Main Control Panel and the Local Control Station(s) shall be provided by the Contractor.
13. All terminals utilized in the control panel shall be 600V rated terminals and 20% spare terminal space shall be provided.
14. Control panel shall contain a programmable logic controller (PLC). PLC shall be Allen Bradley CompactLogix.
15. The PLC shall include a Modbus TCP communications card.
16. Control panel shall contain an HMI.
17. Surge protection shall be according to Division 26 – Electrical.
18. All other electrical components shall be in accordance with Division 26 – Electrical.
19. Control panel shall include all required air conditioning and ventilation.

B. The control panel shall include the following at minimum:

   a. Hand/Off/Auto (HOA) selector switches for screen and washer compactor.
   b. Hand/Off/Auto (HOA) selector switch for wash water
   c. E-stop pushbutton
   d. Elapsed runtime meter
   e. Indication for 'Power On", "Forward", and necessary faults.
   f. 'Control Power On' indicating light

C. Control panel shall include the following dry contacts for SCADA output:

   1. Run Status
   2. Fault

D. Local Control Station

   a. A local control station shall be provided for the screen and washer compactor, mounted locally at the equipment, and include the following:

      1) 'Forward' pushbutton
      2) 'Jog/Reverse' pushbutton
      3) E-stop

E. Controls

   1. Two speed / two level control: When the lower level switch trips, the rake shall run. When the upper level switch trips the rake shall run at high speed. When the level switch returns to the normal position, an off-delay timer shall be initiated to prevent intermittent equipment starting/stopping. Cycle timing logic shall also be included that functions in parallel with the level control for optimal rake run time.

2.5 SURFACE PREPARATION AND PAINTING

A. All ferrous surfaces (except stainless steel) shall be coated with a pre-primer, primer, and an exterior top coating, or fusion bonded polyester coating suitable for humid/wet environments for superior corrosion protection.

B. Motor(s) and gearbox(s) shall be surface prepared to withstand humid/wet environments for superior corrosion protection.

2.6 ANCHOR BOLTS

A. Anchor bolts and nuts shall be 304 stainless steel and be furnished for each item of equipment by the Contractor.

B. Anchor templates shall be included in the submittal to permit verification of the location of structural elements.

C. Anchor sizes, quantity, and requirements shall be indicated on the submittal drawings.

1. Typically, each screen assembly requires (8) to (12) 1/2" dia. x 4 1/2" Lg. embed HILTI KWIK bolt TZ for mechanical screen anchorage and typically (8) to (12) 3/8" dia. x 3 3/8" Lg. embed HILTI KWIK bolt TZ anchors for the return guide/closeouts anchorage.
2. Typically, each washer compactor assembly requires (4) 1/2" dia. x 4 1/2" Lg. embed HILTI HAS RODS with RE-500v3 adhesive system anchors.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that facility is ready to receive mechanical screen and screenings washer/compactor.

3.2 INSTALLATION

A. Install mechanical screen and screenings washer compactor according to manufacturer's instructions and recommendations.

3.3 FIELD QUALITY CONTROL

A. Section 01 40 00 – Quality Requirements: Requirements for inspecting and testing.

B. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

C. Manufacturer Services:

1. Start-up

a. Furnish the services of a factory representative, having complete knowledge of proper operation, start-up procedure and maintenance requirements, for not less than one (1) eight (8) hour days, to inspect the final installation and supervise a test run of the mechanical screen and screenings washer/compactor.

2. Training

a. Furnish the services of a factory representative, having complete knowledge of the operation and maintenance requirements of the system, to instruct the Owner's personnel in the proper operation of the equipment. Training for proper operation and maintenance of the equipment shall be scheduled for one (1) eight (8) hour day and shall be concurrent with trip to site required for start-up.

D. Equipment Acceptance:

1. Adjust, repair, modify, or replace components failing to perform as specified, and rerun tests.
2. Make final adjustments to equipment under direction of manufacturer's representative.

E. Furnish installation certificate from equipment manufacturer's representative attesting equipment has been properly installed and is ready for startup and testing.

3.4 ASSEMBLY, INSPECTION, AND TESTING

A. Following installation, operating tests will be performed to demonstrate to the Engineer that each mechanism and the system as a whole will function in a satisfactory manner. The Contractor shall make, at Contractor's own expense, all necessary changes, modifications, and/or adjustments required to ensure satisfactory operation.

3.5 DEMONSTRATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION 46 21 15

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 46 33 41 - LIQUID CHEMICAL FEED SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Skid- Mounted Sodium Hypochlorite Feed Pumps
2. Control panels.
3. Installation requirements.

B. Related Requirements:

1. Division 01 – General Requirements
2. Division 26 - Electrical

1.2 REFERENCE STANDARDS

A. Instrument Society of America:

1. ISA 5.1 - Instrumentation Symbols and Identification.
2. ISA 20 - Specification Forms for Process Measurement and Control Instruments Primary Elements and Control Valves.

1.3 COORDINATION

A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.

B. Integrate instrumentation and control devices provided under other Sections.

C. Resolve signal, power, or functional incompatibilities among interfacing devices.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer's information with each instrument data sheet.

C. Shop Drawings:

1. Symbology and Nomenclature: Comply with ISA 5.1.
2. Indicate interfaces between instruments, motor starters, control valves, variable-speed drives, flow meters, and chemical feeders.

D. Data Sheets:

1. Comply with ISA 20.
2. Submit following:

    a. Manufacturer's model number or designation.
    b. Component system or loop.
    c. Installation location.
    d. Input and output characteristics.
    e. Scale, range and units.
    f. Requirements for electric and plant water requirements.
    g. Materials of component parts in contact with process chemicals.
    h. Special requirements or features.

E. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

G. Manufacturer Reports: Certify that equipment has been installed according to manufacturer instructions.

H. Qualifications Statements:

1. Submit qualifications for system integrator.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Complete loop and schematic diagrams including field and panel wiring, piping and tubing runs, routing, mounting details, and point-to-point diagrams with cable, wire, tube, and termination numbers.

1.6 QUALITY ASSURANCE

A. Instruments Using Common Measurement Principle:

1. Furnish by single manufacturer.
2. Furnish same type, model, or class.

B. System Integrator: Company specializing in integrating chemical feed products specified in this Section with minimum three years' experience.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store materials according to manufacturer instructions.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.8 AMBIENT CONDITIONS

A. Section 01 50 00 - Temporary Facilities and Controls: Requirements for ambient condition control facilities for product storage and installation.

B. Panels and Enclosures: Suitable for operation in locations as indicated on Drawings.

C. Temperature Range: 32 degrees F to 104 degrees F.

D. Relative Humidity: 20 to 90 percent, noncondensing.

1.9 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

1.10 MAINTENANCE MATERIALS

A. Provide the following spare parts:

1. Peristaltic pumps:

a. Provide two spare tube elements

1.11 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. Furnish five-year manufacturer's warranty for liquid feed equipment systems.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Liquid Chemical Feed Systems:

1. Verder
2. Watson Marlow
3. Approved Equal

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. Sodium Hypochlorite Feed System:

1. Chemical Characteristics:

   a. Dosing Chemical: NaOCl.
   b. Physical state: Clear to slightly greenish-yellow liquid
   c. Concentration by weight: 6.0 percent
   d. Specific gravity: 1.09 @ 60 degrees F
   e. Minimum temperature: 55 degrees F
   f. Maximum temperature: 95 degrees F

2. The equipment to be provided shall include, but is not necessarily limited to, the following:

   a. Two (2) skid mounted peristaltic metering pumps with integral controls.

      1) Design Normal Feed Rate: 3.33 gph
      2) Design Maximum Feed Rate: 6.25 gph
      3) Max Backpressure: 30 psi

   b. Sodium Hypochlorite system control to be complete with the following:

      1) Integral Drive suitable for 120 V, single phase with an internal switch-mode power supply.
      2) Color LCD touch screen Operations Interface Terminal (OIT)
      3) All necessary conduit, wire, boxes, etc., required for complete system interconnection

3. All necessary valves, instrumentation and ancillary equipment necessary to make the system completely operational.

2.3 PERISTALTIC TUBE PUMPS

A. Pump Head

1. Pump head shall consist of a fixed track, a hinged guard door, two spring-loaded tube clamp mechanisms, and spring-loaded roller rotor assembly. Pump tubing shall be in contact with the inside diameter of the track through an angle of 180 degrees and be held in place on the suction and discharge by a spring loaded self-adjusting clamp mechanism. At all times, one roller shall be fully engaged with the tubing providing complete compression and preventing back flow or siphoning. Tube occlusion and spring tension shall be factory set to accommodate 2.4mm wall thickness tubing and shall not require adjustment for accommodating tubing of 1.6mm to 9.6mm ID.

2. Pump head guard shall be transparent for purpose of viewing direction of rotation. For operator and environmental safety, pumps in which the direction of rotation cannot be visually verified are not acceptable.

    a. Pump Head Assembly

        1) Pump Track Geometry must have a minimum 110 mm swept diameter through a minimum track angle of 180 degrees
        2) Provide high corrosion/impact materials as specified

            a) Track Construction: polyphenylene sulfide (PPS)
            b) Guard Construction: hinged impact-resistant polycarbonate breakaway guard, with magnetic switch to stop the pump in the event of the guard opening.
            c) Rotor Construction: polyphenylene sulfide (PPS)

    b. Tube Retainer Mechanism

        1) Provide two spring–loaded adjustable tube retainer mechanism to secure the tubing at the entry and exit points of the pump head

    c. Rotor Assembly

        1) Provide rotor assembly that ensures gradual tube occlusion and compensates for tube tolerance:

            a) Twin spring-loaded roller arms located 180 degrees apart, each fitted with stainless steel helical springs and compressing roller for occlusion of the tube twice per rotor revolution
            b) Compressing Rollers: 316SS with low friction stainless steel bearings and PTFE seals, minimum diameter of 18mm
            c) Provide non-compressing guide rollers constructed of corrosion resistant material
            d) Rotor assemblies that utilize non spring-loaded rollers are not acceptable

        2) Mounting: To prevent slip, the rotor assembly shall be mounted between two bearings with a bearing strut
        3) Pump heads requiring disassembly or special tools for tube changing are not acceptable.

B. Tubing

1. Pump shall be supplied with a continuous tubing or tube elements with molded fittings, which shall be self-locating when fitted into the pump head. Tubing shall be in contact with the inside diameter of the track (housing) through an angle of 180 degrees and be held in place on the suction and discharge by the element fittings. The tubing shall be replaceable without the use of tools and with no disassembly of the pump head. To achieve maximum service life, pump heads with a track angle of less than 180 degrees and/or without tube elements are not acceptable.

2. Pump tubing shall be constructed of Verderprene, a thermoplastic elastomer with a 64 Shore A durometer and 2.4mm wall thickness.
3. Pump shall readily accept tubing ID's of 3.2mm, 4.8mm, 6.4mm, 8.0mm or 9.6mm without pump adjustment or replacement. Tubing with a wall thickness less than 2.4mm is not acceptable.
4. Tubing shall be replaceable without removing the pump head.

C. Drive

1. Rating: Continuous 24-hour operation, 40 deg C ambient.
2. Supply: 110-120V 60 Hz, 1-Phase field switchable. Supply nine-foot length power cord with standard 115V three-prong plug.
3. Max drive power consumption: 230W.
4. Enclosure: NEMA 4X
5. Housing: Pressure cast aluminum with Alocrom pre-treatment and exterior grade corrosion resistant polyester powder coat. By nature of the environmental conditions, unpainted housings, including 316SS, are not acceptable.
6. Drive motor - DC stepper motor.
7. 12-bit resolution for 4,096:1 maximum speed range.
8. Mounting: Drive shall be self-supporting, fully enclosed, and shall not require anchoring.

2.4 CONTROLS

A. Pumps shall meet the following minimum requirements for operator interface functionality.

1. Full-color touchscreen HMI interface, minimum 4.5” diagonal screen size.
2. Pushbuttons for start and stop.
3. HMI to provide speed increment, speed decrement, forward/reverse direction, and programming.
4. Menu driven on screen programming of manual or auto control, flow and remote signal calibration, and general programming.
5. Programmable “Auto Restart” feature to resume pump status in the event of power outage interruption.
6. Programmable “Keypad Lock” to allow operator lockout of all keys except emergency start/stop.
7. Programmable “Maximum Speed” to allow operator to set the maximum speed of the pump.
8. HMI Pod shall contain the pump motherboard and be field replaceable in the event of a failure.
9. Storage of Event Log Files
10. USB Port

    a. For Field Updating of Pump
    b. For Field Removeable log files
    c. For Field Backup & Restore of Pump Programming.

B. Supply automatic control features to meet the following minimum functionality requirements for use with SCADA system:

1. Remote Control Inputs

a. Speed Control: 4-20mA or 0-10VDC speed input, with input signal trimmable and speed scalable over any part of the drive speed range.
b. Start Control: via 24 volt relay input or optional 120 Volt Input.
c. Stop Control: via 24 volt relay input or optional 120 Volt Input.
d. Forward/Reverse Control: via 24 volt relay input or optional 120 Volt Input.
e. Auto/Manual Mode Control: via 24 volt relay input or optional 120 Volt Input.

2. Status Outputs

a. Four relay contacts rated for a max. current of 2A at 120V, NO or NC software configurable to indicate the following:
b. Start/Stop status
c. Forward/Reverse status
d. General Alarm status
e. Leak Detected status
f. Analog Status
g. Manual/Auto Status
h. Speed output – Analog 4-20mA or 0-10 VDC

3. Termination: supply screw down terminals suitable for up to 18 AWG field wire and accessible through four glanded cable entry points on the pump

C. Leak Detection: Pump manufacturer shall supply optical leak sensor mounted within the pump head for leak detection and pump shut down in the event of a tubing failure

2.5 CHEMICAL FEED SKID AND APPURTENANCES

A. Responsibility

1. In order to provide a fully integrated solution, the pump manufacturer shall be responsible for providing as a complete package: pumps, skid, and all necessary piping, valves, gaskets, hardware, and appurtenances for a fully functioning chemical feed system.
2. Assembled skid shall be tested by manufacturer. Skid shall hold pressure and be drip-proof at 90 psi for 12 hours. Provide certification of these tests.

B. Skid Construction

1. Skid shall consist of welded HDPE.
2. Skid shall be floor mounted.
3. Skid shall incorporate provisions for leak containment and drainage.
4. Skid shall incorporate forklift slots for easy lifting and placement.
5. Piping to be solvent-welded schedule 80 PVC. Ball Valves to utilize chemically compatible seats & o-rings. Connect pump suction and discharge to PVC piping with translucent flexible lines for verification of flow and easy access to pump ports for maintenance. Pipe supports and clips to be non-metallic, chemical and corrosion-resistant. Terminate suction and discharge piping within 2” of skid boundary.
6. Bottom of skid shall be extended to where pumps are at approximately waist level.

C. Appurtenances

1. Appurtenances shall be adequately sized and constructed from materials compatible with the process.
2. Each pump shall have dedicated isolation valves and drain/sample ports.
3. Each pump shall have dedicated chargeable, appendage-style discharge pulsation dampeners. Dampeners shall incorporate a pressure gauge to monitor charge pressure. Dampeners to be manufactured by Blacoh or equal.
4. Each pump shall have dedicated pressure gauges with isolation diaphragms. Pressure gauges to be liquid-filled, 0-100 psi pressure range. Include pressure gauge calibration reports with Operation and Maintenance Data.

D. Each pump shall have dedicated adjustable pressure relief valves. Pressure relief valves shall be factory set. Pressure relief valves should relieve back to pump suction through clear PVC for visual verification that the valve is relieving.

E. Skid to incorporate a vented calibration column that can be used by either pump.

F. Skid to incorporate an appropriately sized Y-Strainer on the inlet prior to both pumps.

2.6 CORROSION PROTECTION

A. Electrically isolate dissimilar metals or connectors in direct contact

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install pump skids per manufacturer's instructions

B. Mount skids where shown on Drawings

C. Fit and align connecting piping to eliminate all stresses

D. Install combination backpressure and anti-siphon valve, pressure relief valve and pulsation dampener on the discharge of each chemical feed as close to the pumps as possible

3.2 START-UP AND PERFORMANCE WARRANTY TESTS

A. Make equipment adjustments required to place system in proper operating condition.

B. Test each feed system for proper operation in the presence of the Owner. All testing costs are the Contractors.

C. Furnish all testing equipment, special instruments and devices required for performance testing.

D. Modify and/or replace defective equipment until it meets specified requirements. Re-test system to verify satisfactory operation.

E. Demonstrate the accuracy of each metering pump using job supplied calibration column.

3.3 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

B. Calibration:

1. Calibrate each instrument at 40, 60 and 100 percent of its span using test instruments to simulate inputs.
2. Field-calibrate instruments that were not bench-calibrated.
3. Tags: Attach calibration and testing tag to each device, signed and dated by device manufacturer's representative after calibration has been completed.

C. After installation, inspect and test for proper operation.

D. Manufacturer Services: Furnish services of manufacturer's representative experienced in installation of products furnished under this Section for not less than 2 days, (16 hours) on Site for installation, inspection, startup, field testing, and instructing Owner's personnel in operation and maintenance of equipment.

E. Equipment Acceptance:

1. Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.
2. Make final adjustments to equipment under direction of manufacturer's representative.

3.4 DEMONSTRATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate system startup, shutdown, routine maintenance, alarm condition responses, and emergency repair procedures to Owner's personnel.

END OF SECTION 46 33 41

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 46 33 66 - LIQUID CHEMICAL TRANSFER PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Magnetic driven centrifugal transfer pumps and accessories
2. Control panel

B. Related Requirements:

1. Division 26 – Electrical
2. Division 40 – Process Interconnections
3. Section 40 70 23 – Process Control Narratives

1.2 COORDINATION

A. Integrate instrumentation and control devices provided under other Sections.

B. Resolve signal, power, or functional incompatibilities among interfacing devices.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer's information with each instrument data sheet.

C. Shop Drawings:

1. Symbology and Nomenclature: Comply with ISA 5.1.
2. Indicate interfaces between instruments, motor starters, control valves, variable-speed drives, flow meters, and chemical feeders.

D. Data Sheets:

1. Comply with ISA 20.
2. Submit following:

a. Manufacturer's model number or designation.
b. Component system or loop.
c. Installation location.
d. Input and output characteristics.
e. Scale, range and units.
f. Requirements for electric and plant water requirements.
g. Materials of component parts in contact with process chemicals.

h. Special requirements or features.

E. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

G. Manufacturer Reports: Certify that equipment has been installed according to manufacturer instructions.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Complete loop and schematic diagrams including field and panel wiring, piping and tubing runs, routing, mounting details, and point-to-point diagrams with cable, wire, tube, and termination numbers.

C. Operation and Maintenance Data: Submit maintenance instructions for equipment and accessories.

1.5 QUALITY ASSURANCE

A. Ensure that materials of construction on pump liquid end are compatible with chemicals listed:

1. Furnish by single manufacturer.
2. Furnish same type, model, or class.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store materials according to manufacturer instructions.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.7 SPARE PARTS

A. Uninstalled Spare Chemical Transfer Pumps

1. One (1) magnetic driven centrifugal transfer pumps capable of pumping 20 GPM at 10 ft TDH, minimum.

1.8 AMBIENT CONDITIONS

A. Section 01 50 00 - Temporary Facilities and Controls: Requirements for ambient condition control facilities for product storage and installation.

B. Panels and Enclosures: Suitable for operation in locations as indicated on Drawings.

C. Temperature Range: 32 degrees F to 104 degrees F.

D. Relative Humidity: 20 to 90 percent, noncondensing.

E. Instrumentation in Hazardous Areas: Suitable for use in particular hazardous or classified location.

1.9 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

1.10 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. The Manufacturer and Contractor shall furnish a warranty extending twelve (12) months after substantial completion date.

C. The Manufacturer shall furnish a warranty extending twenty-four (24) months after substantial completion date on the mechanical drive.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Magnetic Drive Centrifugal Pumps:

1. March Manufacturing – Glenview, IL
2. T-Mag Magnetic Drive Pumps – Brookfield, WI
3. Iwaki America Inc. – Holliston, MA
4. Or Approved Equal

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. Sodium Hypochlorite Transfer Pump:

1. Equipment:

a. One (1) Magnetic Driven Transfer Pump

1) Feed Rate (GPM): 20
2) TDH: 10 feet
3) HP: 1/3

b. All necessary valves, instrumentation and ancillary equipment necessary to make the system completely operational.

2. Dosing Chemical: Sodium Hypochlorite

a. Physical state: Clear to slightly greenish-yellow liquid
b. Concentration by weight: 12.5 percent
c. Specific gravity: 1.09 @ 60 degrees F
d. Viscosity: 1.17 to 1.53 cPs
e. Minimum temperature: 55 degrees F
f. Maximum temperature: 95 degrees F

2.3 MATERIALS

A. Magnetic Drive Pump

1. Pump housing and impeller: corrosion resistant and high impact resistant glass filled PPS or PPE/PS.
2. Magnetic coupling: inner drive neodymium iron boron magnets encapsulated in unfilled polypropylene, outer drive nickel plated neodymium iron boron magnets/steel.
3. Fiberglass base for entire pump assembly.
4. Impeller housing tangential discharge.
5. Back pull out design.
6. Maximum temperature 200°F
7. Minimum temperature 32°F
8. Motor: TEFC, 115/230 V, 1 PH, 60Hz
9. Rated for continuous outdoor duty.

2.4 CONTROLS

A. Simplex control panel devices in accordance with Division 26 requirements. Refer to Specification Section 26 29 00 - Manufactured Control Panels for additional requirements.

B. Provide and tag terminal blocks as required for power and motor leads.

C. Enclosures: NEMA 4X

D. Control Wiring:

1. Material: Copper.
2. Minimum Size: No. 16 AWG.
3. Tagging:

a. Tag control wiring at both ends with legible permanent-coded wire-marking sleeve.
b. Mark with white PVC tubing sleeves with machine-printed black marking.
c. Mark according to wire numbers as indicated on control wiring diagrams and terminal strip numbers.

E. Pilot lights: On (green), Off (red)

F. Power supply per unit: 115/230 V, single phase, 60 Hz. Provide complete with nine-foot length main power cord with standard three-prong plug. Minimum operator controls and monitoring:

1. Circuit breaker protected main power ON-OFF with indicator light
2. Terminal blocks sized for 12 ga. wire, numbered and with legend
3. On/Off switch
4. Run indicating light
5. Fault indicating light

2.5 CORROSION PROTECTION

A. Electrically isolate dissimilar metals or connectors in direct contact

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install pumps per manufacturer's instructions

B. Install pumps where shown on Drawings

C. Fit and align connecting piping to eliminate all stresses

3.2 START-UP AND PERFORMANCE WARRANTY TESTS

A. Make equipment adjustments required to place system in proper operating condition.

B. Test each feed system for proper operation in the presence of the Owner. All testing costs are the Contractors.

C. Furnish all testing equipment, special instruments and devices required for performance testing.

D. Modify and/or replace defective equipment until it meets specified requirements. Re-test system to verify satisfactory operation.

E. Demonstrate the accuracy of each metering pump using job supplied calibration column.

3.3 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

B. After installation, inspect and test for proper operation.

C. Manufacturer Services: Furnish services of manufacturer's representative experienced in installation of products furnished under this Section for not less than one (1) 8-hour day on Site for installation: inspection, startup, field testing, and instructing Owner's personnel in maintenance of equipment.

D. Equipment Acceptance:

1. Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.
2. Make final adjustments to equipment under direction of manufacturer's representative.

3.4 DEMONSTRATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate system startup, shutdown, routine maintenance, alarm condition responses, and emergency repair procedures to Owner's personnel.

END OF SECTION 46 33 66

SECTION 46 43 81 – FIBERGLASS REINFORCED PLASTIC WEIRS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes fiberglass reinforced plastic (FRP) weir plates where indicated on Drawings.

B. FRP weir plates are to be installed in the existing aeration basin. Contractor shall field verify dimensions before replacement.

1.2 QUALITY ASSURANCE

A. Manufacturer shall be a reputable qualified manufacturer of FRP products.

1.3 SUBMITTALS

A. The following shall be submitted in accordance with the General and Special Provisions.

1. Shop Drawings

    a. Dimensions
    b. Layout
    c. Sectional Assembly
    d. Location and identification markings
    e. Accessories, attachments, transition pieces
    f. Connection Details

2. Manufacturer’s catalog data showing:

    a. Dimensions, spacing, and construction details
    b. Materials of construction
    c. Description

3. Certificates

    a. Submit Manufacturer’s certification that all materials furnished are in compliance with the applicable requirements of this specification

4. Manufacturer’s Instructions

    a. Submit complete information and instructions relating to storage, handling, installation, and inspection of all equipment related to this Section.

1.4 STORAGE AND TRANSPORTATION

A. All FRP components shall be shop fabricated and assembled as much as possible

B. The parts and assemblies that are shipped unassembled shall be packaged and tagged in a manner that will protect the equipment from damage and facilitate the final assembly in the field.

C. All FRP materials shall be stored until installation in a manner that prevents cracking, chipping, or damage to the materials.

1.5 WARRANTY

A. Manufacturer shall warrant the equipment furnished under this section to be free of defects in materials and workmanship for a period of five (5) years after the date of Substantial Completion.

PART 2 - PRODUCTS

2.1 FRP WEIR PLATES

A. Manufacturer

1. Warminster Fiberglass Company
2. Approved Equal

B. Design

1. Weir Plates and Brackets: Fiberglass reinforced polyester resin, compression molded in matched metal die molds; provide all required lap plates, cover plates, and support brackets.
2. Fiberglass Laminate Construction: Sheet Molding Compound (SMC) for use in water treatment systems.

    a. Glass content of laminate; 28 percent plus/minus 3 percent by weight. Resin fillers: 40 percent plus/minus 2 percent of resin mixture.
    b. Final laminate thickness: Plus/minus 10 percent of nominal specified thickness.
    c. Tensile strength (ASTM D 638): 14,000 psi.
    d. Flexural strength (ASTM D 790): 25,000 psi.
    e. Flexural modulus (ASTM D 790): 1,000,000 psi.
    f. Impact, notched, Izod (ASTM D 256): 15 ft/in.
    g. Barcol hardness (resin-rich surface) (ASTM D 2583): 40 minimum, average.
    h. Water absorption (ASTM D 570): 0.1 percent at 24 hrs.
    i. Coefficient of thermal expansion, ave. (ASTM D 696): 0.0000105 in/in/degree F.
    j. Test coupons prepared in accordance with ASTM D 618.
    k. Chemical resistance: Comply with ANSI/AWWA F102, Type II classification.

3. Weir Plates

    a. Weir plates shall be 12” high (min.), 1/4” thick, with 3” high, 90° V-notches on 6” centers.
    b. Mounting holes shall provide a minimum of 2 inches vertical or horizontal adjustment.
    c. Provide FRP cover washers and lap plates.

4. Anchorage

    a. Support brackets shall be provided with stainless steel anchorage/hardware.
    b. Weir plates shall be provided with 1/2” diameter stainless steel anchor bolts and 5” square fiberglass cover plates to prevent short circuiting.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The installation contractor shall field verify existing dimensions and install the weirs in accordance with the contract drawings, approved shop drawings and manufacturer’s recommendations. Mounting holes shall be factory drilled. All field cut or drilled edges shall be coated per the manufacturer’s recommendations to prevent fiber blooming or fraying.

B. All of the fasteners required for installation shall be supplied by the baffle manufacturer.

C. The weir plates shall extend a minimum of 6” beyond wall’s interior edge and shall be level, rigid and free of sway that could work anchors loose or cause undue wear.

END OF SECTION 46 43 81

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 46 51 46 – FINE BUBBLE DIFFUSERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fine Bubble Diffusers

B. Related Requirements:

1. Division 01 – General Requirements
2. Section 03 20 00 – Anchorage in Concrete

1.2 SUBMITTALS

A. Submittals shall be provided in accordance with Section 01 33 00 - Submittal Procedures and include the following:

1. Manufacturer's literature, dimensional drawings, performance data, materials of construction, and any other information necessary to determine compliance of the equipment to the specification and project requirements.
2. Highlight project-specific model numbers and options in equipment data sheets.
3. Submittal drawings showing plan, elevation and cross sections of the equipment.
4. Component details of the aeration equipment showing diffusers, diffuser holders, gaskets, retainer rings, supports, threaded union and/or flanged joints.
5. Materials and Manufacturing specifications.
6. Aeration System submittal information to include:

    a. Equipment data sheets
    b. Performance data including oxygen transfer calculations
    c. Certified SOTE curves from previous test runs on equivalent system shop transfer testing.
    d. Headloss calculations and pressure requirements.
    e. Recommended spare parts lists and predicted life of parts subjected to wear.
    f. Membrane longevity test reports.
    g. Heat transfer calculations.

7. Operation and maintenance manual with installation instructions. Submit after approval of equipment with equipment shipment.

1.3 OPERATION AND MAINTENANCE MANUALS

A. Complete system Operation and Maintenance manuals shall be available in hardcopy and electronic form according to Specification 01 78 23 – Operation and Maintenance Data.

1.4 SPARE PARTS

A. The Manufacturer shall provide one (1) set of recommended spare parts.

B. The Manufacturer shall furnish any special tools necessary to disassemble, service, repair, and adjust the equipment.

1.5 QUALITY CONTROL

A. Shop Oxygen Transfer Test

1. Conduct a performance test to demonstrate capability of the aeration equipment to meet the specified oxygen transfer requirements
2. Base all tests on the following criteria:

   a. Two design conditions at each diffuser density will be tested. In the case of more than three densities on a project, the Engineer will define zones to be tested after award of the project.
   b. A minimum of 3 test runs for each specified design condition to be run in complete accordance with ASCE Clean Water Test Procedure (2006 or latest edition)
   c. Conduct tests in a full scale aeration test tank (minimum of 300 sq. ft.) at the specified submergence and water depth with a diffuser density equivalent to the specified tank configuration. Diffuser density is defined as the ratio of the total tank surface area to the total active diffuser surface area.
   d. Conduct shop test with air rate and mass rate of oxygen transfer directly proportional to the ratio of the shop test tank volume and the design tank volume.
   e. Plot of standard condition pounds of oxygen transferred per day per 1000 cubic feet of tank volume versus standard condition cubic feet of air per minute per 1000 cubic feet of tank volume. (lbs-02/day/1000 cubic feet-tank) vs. (SCFM/1000 cubic feet-tank)
   f. Standard conditions of oxygen transfer are defined as 68 °F, 1 atmosphere ambient pressure, clean water.
   g. Standard air is defined as 68 °F, 1 atmosphere, 36% R.H., containing 23% oxygen by weight.

3. Certify and stamp all tests by a Professional Engineer.
4. Submit all test data from oxygen transfer tests for approval by the Engineer prior to manufacturing equipment.

1.6 WARRANTY

A. The Manufacturer shall provide a written warranty against defects in materials and workmanship. Manufacturer shall warrant the goods provided by the Manufacturer to be free from defects in materials and workmanship under normal conditions and use for a period of one (1) year from the date the goods are put into service, or eighteen (18) months from shipment of equipment, whichever first shall occur.

PART 2 - PRODUCTS

2.1 FIXED FINE BUBBLE DIFFUSED AERATION SYSTEM

A. The fine bubble diffusers shall be manufactured by:

1. Sanitaire (Xylem)
2. Or Pre-Approved Equal

B. Location

1. The fine bubble diffusers shall be installed in the existing aerobic digesters.

C. General

1. Provide the following components.

a. Stainless steel supports, and anchors.
b. PVC manifolds, air distributors, diffuser holders, and retainer rings
c. Bolts, nuts and gaskets for aeration system flange connections.
d. Membrane disc diffusers with integral O-ring gaskets.

D. System Design and Performance

1. Design aeration system to transfer not less than the following pounds of oxygen per day in clean water at 14.7 PSI, 20°C and zero dissolved oxygen at the specified submergence, air rate and pressure.

Tank	Digester
Tank Size (Each)	57’L X 57’W X 16’SWD
Number of Tanks	3
Delivered Oxygen Transfer Efficiency (%)	31.9
Max Volumetric Air Rate (SCFM per Basin)	1,500
Operating Pressure at Top of Dropleg (psig)	7
Diffuser Submergence (@ High Water Depth – ft)	14.95
#Diffusers/Tank	832

2. Design air distributors with centerline spacing not to exceed 4 feet to maximize oxygen transfer efficiency and mixing efficiency and to minimize solids deposition between air distributors.

E. Materials, Fabrication and Finishing

1. Stainless Steel – Pipe, Fittings and Supports

a. Fabricate all welded parts and assemblies from sheets and plates of 304L stainless steel with a 2D finish conforming to ASTM A240, 554, 774, 778.
b. Fabricate non-welded parts and flanges from sheets, plates or bars of 304 stainless steel conforming to ASTM A240 or ASTM A276.
c. Welds & Welding Procedure:

1) Weld in the factory using latest standards according to AWS. Continuously weld both sides of face rings and flanges to eliminate potential for crevice corrosion.

d. Corrosion Protection and Finishing: Clean all welded stainless steel surfaces and welds after fabrication by using the following procedure:

1) Pre-clean all outside weld areas to remove weld splatter with stainless steel brushes and/or deburring and finish grinding wheels.
2) Finish clean all interior and exterior welds and piping by full immersion pickling and rinse with water to remove all carbon deposits and contaminants to regenerate a uniform corrosion resistant chromium oxide film per ASTM A380 Section 6.2.11, Table A2.1 Annex A2 and Section 8.3.

2. Natural Rubber – Furnish all fixed and expansion joint O-ring gaskets of natural rubber/SBR with a Shore A durometer of 45 ± 5.
3. Polyvinyl Chloride (PVC) – Pipe and Fittings
   a. Provide lower drop pipe, manifold and air distributors as follows:

Diameter	Wall Thickness	ASTM
4”	SDR 33.5	D3915, 3034,124524
6" & larger	Schedule 40	D1784, D1785, D2466,12454-B

   b. Design air distributors and manifolds to withstand 130° F mean wall temperature.
   c. Add two parts by weight of titanium dioxide per 100 parts of resin to PVC compounds for manifolds, air distributors, joints and PVC diffuser assembly components to minimize ultraviolet light degradation.
   d. Factory solvent weld all PVC joints and fittings. Field solvent welding will not be permitted.

4. EPDM - Membrane Diffusers and Gaskets

   a. Manufacture circular membrane diffuser discs with integral O-ring of EPDM synthetic rubber compound with precision die formed slits. Thermoplastic materials (i.e. plasticized PVC or polyurethane) are not acceptable.
   b. Add carbon black to the material for resistance to ultraviolet light.
   c. Diffuser shall be designed as one-piece injection molded part with a minimum thickness of 0.08 inches for 9-inch diameter unit.
   d. Limit the maximum tensile strength of the diffuser to 10 psi when operating at 2.4 SCFM/ft² of material. Furnish proportionately thicker material for larger diameter disc diffusers to limit the maximum tensile stress and to resist stretching.
   e. Produce diffusers free of tears, voids, bubbles, creases or other structural defects.
   f. Quality Control – Test diffuser using primary sampling criteria outlined in Military Standard 105E.
   g. Membrane Longevity

      1) Longevity of the proposed membrane diffusers shall have been demonstrated in at least three full-scale municipal installations operating continuously for a minimum of three years.

2) Test reports, prepared by an independent testing agency, shall confirm membrane longevity through compliance with the following maximum allowed percent (+/-) change in each membrane property. Tests conducted in-house by the Supplier shall not be acceptable.
3) Data for a minimum of three diffusers from each installation shall be provided.

F. Fine Bubble Aeration System Components

1. Droplegs - Existing 10" dropleg is each digester shall remain in service for use with new manifold and diffuser. The manufacturer shall provide the required connection to the existing 10" air drop leg in each basin.
2. Manifolds – Provide PVC manifolds for connection to the air distribution headers.

   a. Fabricate manifolds with 4-inch diameter fixed threaded union positive locking anti rotational or flanged joints for connection to the air distributors.
   b. Design manifold, distributor connections and supports to resist thrust generated by expansion/contraction of the air distributors over a temperature range of 125 deg F
   c. Support manifold with a minimum of two supports.
   d. Connect manifolds with fixed threaded union or flanged joints to prevent rotation or blow apart.

3. Air Distributors and Diffuser Holders - 4-inch diameter PVC air distributors perpendicular to the air manifold

   a. Fabricate distributors with single diffuser holders solvent welded to the crown of the air distributor for complete air seal and strength.
   b. Provide 4-inch diameter threaded removable end caps complete with gasket, threaded coupling and end plate for clean out at the end of each distributor.

4. Air Distributor and Manifold Connection Joints

   a. Join air distributor sections with threaded union or flange type joints for all submerged header joints. Connections shall be made to prevent blow apart and rotation of joints.
   b. Design threaded union joints with spigot section connected to one end of the distribution header, a threaded socket section connected to the mating distribution header, an O-ring gasket and a threaded screw on retainer ring. Solvent welding shall be done in the factory.
   c. Fixed joints shall be designed to resist 80 ft-lb (5.5 kg-m) torque without joint movement or failure.
   d. All fixed joints shall have interlocking splines and grooves to prevent rotation of the air distributors. All rotational forces shall be transferred through the interlocking splines. Joints that require the o-ring to transfer rotational forces between the splines are not acceptable. If positive locking fixed joints are not used, all distributor connections shall be 125 lb flanges.
   e. Design flanged joints with a 125 lb drilling angle face ring, follower flange and stainless steel hardware.

5. Supports- Provide each section of manifold and air distributor with a minimum of two (2) supports.

a. Limit maximum support spacing to 8 ft.
b. Design all supports to allow for thermal expansion and contraction forces over a temperature range of 125° F and to minimize stress build up in the piping system.
c. Design supports to be adjustable without removing the air distributor from the support .
d. Design supports to allow for complete removal from the tank, less the anchor bolt, to facilitate installation of additional headers and in-tank maintenance. Support structures which consist of rods Epoxied directly into the tank floor are not acceptable.
e. Manifold Support – 6 inch diameter and larger

1) Design supports to include hold down guide straps, support structure and anchor bolts.
2) Design guide straps with a 2 inch minimum width to eliminate point load on manifold and minimize binding.
3) Design support for 2 inches plus or minus vertical adjustment for leveling of manifold.
4) Attach supports to tank floor with two stainless steel anchor bolts.

f. Air Distributor and Manifold Supports – 4 inch diameter.

1) Design supports with hold down straps, support structure and anchor bolt.
2) Design support for 1 1/2 inch(plus or minus) vertical adjustment for leveling air distributor to plus or minus 1/4 inch.

g. Guide support

1) Guide straps to have 1 1/2 inch wide top and bottom contoured bearing surface with chamfered edges to minimize binding and resistance to movement of air distributor under full buoyant uplift load.
2) Design strap with 1/8 inch clearance around distributor so strap is self-limiting and cannot be over tightened.

h. Fixed supports

1) Fixed straps to have 1 1/2 inch wide top and bottom contoured bearing surface with punched burrs to positively grip the air distributor when tightened.
2) Design strap to be self-limiting to prevent stressing the distributor if the clamp is over tightened.

i. Attach air distributor supports to tank floor with one stainless steel anchor bolt. Attach manifold supports to tank floor with two stainless steel anchor bolts.

6. Diffuser Assemblies - Furnish diffuser assemblies including diffuser, diffuser gasket, holder, retaining ring and air flow control orifice.

a. Membrane Diffuser

1) Incorporate an integral check valve into the membrane diffuser.

b. Design and test diffusers for a dynamic wet pressure (DWP) of 5 inches ± 20% water column @ 1.0 SCFM/diffuser and 2 inches submergence.
c. Visual Uniformity – Observe diffusers for uniform air distribution across the active surface of the diffuser at 1.0 SCFM/diffuser and 2 inches submergence. Active surface is defined as the perforated horizontal projected area of the diffuser.
d. SCFM defined at 20°C, 1 atm, 36% RH
e. Quality Control – Test diffuser using primary sampling criteria outlined in Military Standard 105E.

7. Diffuser Holders and Retainer Rings

a. Design holder with air flow control orifice. Holder shall provide peripheral support for the diffuser.
b. Design retainer ring to seal the diffuser and O-ring in the holder to prevent air leakage around gasket.
c. Design retainer rings threads with minimum cross section of 1/8-inch and allow for one complete turn to engage threads.

8. Anchor Bolts

a. Provide a mechanical 304 SS expansion anchor bolts for embedment in 4000 psi concrete with a pullout safety factor of 4.

9. Liquid Purge System

a. Provide a liquid purge system to drain the entire submerged aeration piping system for each aeration grid including airlift purge eductor line and manual control valve.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify layout, type, and orientation of connections.

3.2 INSTALLATION

A. Install Diffuser System where indicated on Drawings and according to Supplier/Manufacturer instructions.

B. System supplier shall supply personnel to be present at final equipment installation/inspection. After inspection, any adjustment or corrections deemed necessary for the correct operation of the system shall be detailed by the supplier and performed by the Contractor.

3.3 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.

B. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

C. Testing:

1. Test equipment at start-up to ensure adequate and evenly distributed air flow through all installed diffusers creating complete mix basins. The supplier shall provide a formal test procedure and forms for recording data. Only factory certified service personnel shall perform start-up service. Proof of certification shall be required prior to equipment approval.

3.4 FIELD SERVICE

A. Furnish the services of a manufacturer's representative, having complete knowledge of proper operation, start-up and maintenance procedures for not less than one (1) trip and two (2) days on site to perform start up and training and to inspect the installation.

B. A written service report shall be provided following dry inspection and wet start up. Contractor shall be responsible for correcting any deficiencies identified during the service visits.

C. The field person shall do a functional check of each item furnished and start-up of the process. During this time, the field representative shall provide operation training, which shall include familiarization with the biological process controls, its requirement and review of the Operation and Maintenance Manuals.

END OF SECTION 46 51 46

SECTION 46 70 11 – MANUAL DILUTION PANEL

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes: manual dilution panel

1.2 SUBMITTALS

A. Section 01 33 00 – Submittal Procedures: Requirements for submittals

B. Submit shop drawings and accessories information.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store materials according to manufacturer instructions.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.4 WARRANTY

A. Manufacturer shall warrant the equipment furnished under this section to be free of defects in materials and workmanship for a period of one (1) year after the date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUAL DILUTION PANEL

A. Manufacturer

1. Emerald Coast Manufacturing
2. Or Approved Equal

B. Description

1. Pre-assembled skid to allow for the dilution of sodium hypochlorite from 12.5% to 6%. Neat sodium hypochlorite shall be pumped into the skid from the neat tank, diluted and transferred to two (2) dilute storage tanks.
2. Dilution panel shall have two (2) product outlets.
3. All piping and appurtenances shall be mounted to a wall-mountable backer board.

C. Components

1. Water line

a. 2” inlet connection
b. 2” wye strainer
c. 2” pressure reducing valve
d. Pressure gauge
e. Two (2) 1” ball valves
f. 1” rotameter

2. Neat chemical line

a. 2” inlet connection
b. Two (2) 1” ball valves
c. 1” rotameter

3. Product outlet line

a. 1” static mixer
b. Two (2) 2” ball valves
c. Two (2) 2” outlets

D. Material

1. All chemical piping shall be Schedule 80 CPVC
2. Water line shall be Schedule 80 PVC.
3. Backer board shall be polypropylene.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify layout and orientation of piping connections.

3.2 INSTALLATION

A. Install dilution panel according to manufacturer's instructions.

3.3 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

B. Inspection: Inspect for proper operation.

C. Manufacturer Services: Furnish services of manufacturer's representative experienced in installation of products furnished under this Section for not less than one (1) trips and one (1) day on site for installation, inspection, startup, field testing, and instructing Owner's personnel in maintenance of equipment.

3.4 DEMONSTRATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION 46 70 11

THIS PAGE INTENTIONALLY LEFT BLANK