Specifications For:

City of Thorne Bay, Alaska

Wastewater Disinfection Improvements

March 2018

Volume 1 of 1

Divisions 1-41

Prepared For: City of Thorne Bay PO Box 19110 Thorne Bay, AK 99919

Prepared By:



3535 College Road, Suite 100 Fairbanks, AK 99709 (907)374-0875 Project No. 4528.50093.01



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Appendix A Glasco Scope

SECTION 011000 - SUMMARY OF WORK

PART 1 -- GENERAL

- 1.1 SCOPE
 - A. The scope of this section includes general project description, site access, coordination and various project details.
 - B. RELATED SECTIONS
 - 1. Section 017500 Startup and Commissioning
- 1.2 PROJECT INFORMATION
 - A. General
 - 1. Project includes modifications to the existing chlorine contact basin and installation of a new ultraviolet disinfection system within the existing basin. The project also includes structural grating over the existing basin, electrical and system controls installation/connection and installation of a new emergency backup generator.
 - B. Owner-procured Equipment
 - 1. The Owner has purchased equipment through a competitive proposal process. The respective equipment suppliers are under contract with the City to supply and commission the equipment.
 - a. The full, approved equipment submittals are included as attachments to the contract documents for Contractor's reference and use in installing the equipment.
 - b. The division of work and supply is generally delineated in the Construction Drawings but the full scope of supply is provided in the respective, approved submittal documents.
 - c. It is the Contractor's responsibility to understand the scope of equipment supply and account for installation, testing and commissioning of the equipment in accordance with approved submittal documents included as part of these contract documents.
 - d. The contract with the manufacturers for supply of the equipment will remain with the City. No contract will be assumed by Contractor.
 - e. The Contractor will assume full responsibility for installation in accordance with the manufacturer's instructions, and coordinating startup assistance, testing, and operator training with the manufacturer.
 - f. The Owner procured equipment will be on-site prior to issuing the Contractor's "Notice to Proceed": The estimated equipment delivery date is:
 - i. Ultraviolet Disinfection System (Glasco UV): January 2018

- g. In the event of equipment delivery delay beyond these stated time frames, Contractor shall make no claim for delay for a delivery delay up to and including 30 days.
- h. All payment to the equipment manufacturers will be by the Owner.
- 2. Ultraviolet (UV) Disinfection System:
 - a. The City has procured/purchased the UV disinfection system. Glasco UV is under contract to supply the UV disinfection equipment and controls.
 - b. The full scope of supply is identified in the equipment submittals included in the appendices and more generally delineated in the construction drawings.
 - c. For reference to installation instructions, pre-startup checklists Contractor shall refer to the equipment submittals included in the appendices.

1.2 PROJECT DESCRIPTION

- A. UV Disinfection System: The existing concrete chlorine contact basin will be modified for the installation of a new UV disinfection system. The UV system has been purchased by the City and will be installed by the Contractor. See project drawings for additional information.
 - 1. The existing basin structural modifications will include grating over the existing basin, stair access to the basin, handrailing, and concrete channel modifications to allow for the installation of the new UV disinfection system.
 - 2. The installation of valving on the existing basin bypass line to direct the flow into the UV system and maintain the bypass line for use in emergency situations. The valving installation will require a temporary shutdown of the treatment facility's discharge. The temporary shutdown shall be closely coordinated with the Owner, temporary bypass pumping may be necessary as part of the shutdown and shall be provided by the Contractor as needed. The Contractor shall submit a bypass plan to the Engineer and Owner for approval.
 - 3. The Contractor shall install the City purchased UV disinfection system, electrical components and controls per the UV manufacturer installation instructions. The Contractor shall coordinate the system startup, commissioning, and training with both the Owner and equipment manufacturer.
- B. Emergency Generator: A new emergency backup generator will be installed at the treatment facility to supply power to the entire treatment facility in the event of a power outage.

1.3 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.

1.4 SURFACE AND SUBSURFACE CONDITIONS

A. The CONTRACTOR shall satisfy himself as to the surface, subsurface, and ground water conditions at the site of the work.

1.5 COORDINATION WITH OCCUPANTS

- A. Partial Owner Occupancy: Owner will occupy the premises during entire construction period, with the exception of areas under construction. Cooperate with Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with Owner's operations. Maintain existing exits unless otherwise indicated.
 - 1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from Owner and authorities having jurisdiction.
 - 2. Provide not less than 72 hours notice to Owner of activities that will affect Owner's operations.
- B. Use of Premises.
 - 1. The CONTRACTOR shall confine his operations to existing rights of way, easements, and designated construction corridors at the site of the proposed work.
- C. Security
 - CONTRACTOR shall be responsible for the security of all materials, equipment, tools, etc. used on the job. All materials which can be easily removed shall be stored in a locked building provided by the CONTRACTOR. All material inventoried and in storage which has been paid for on monthly progress payments must be in Owner's possession and stored on-site or at a secure location acceptable to the OWNER and ENGINEER.

1.6 EXISTING FACILITIES

- A. Existing Treatment Facility
 - 1. The WORK will be executed while the existing wastewater treatment facility is in operation. Operation of the existing treatment facility/process shall not be jeopardized nor shall the capacity or efficiency of treatment be reduced as a result of the execution of the WORK, unless specifically stated.
 - 2. The CONTRACTOR shall take necessary precautions to ensure that no damage occurs to the plant facilities, including piping, utilities, roads, building, and structures, that are to remain in operation and are not to be modified or replaced. Any temporary facilities, materials, equipment, and labor required for the plant to continue to operation during construction shall be provided by the CONTRACTOR as part of the

WORK. At the completion of work, such temporary facilities, materials, and equipment shall be removed from the Site as part of the WORK.

- 3. Unless indicated otherwise, temporary pumping, piping, power, lighting, controls, instrumentation, alarms, security devices, and safety devices shall be provided by the CONTRACTOR whenever its activity or interruption due to its activity affects the existing facility.
- B. Protection of Existing Utilities
 - 1. Existing underground installations such as water mains, gas mains, sewers lines, stormwater mains, telephone lines, power lines, and buried structures in the vicinity of the work to be done hereunder are indicated on the drawings only to the extent such information has been made available to or discovered by the ENGINEER in preparing the drawings. There is no guarantee as to the accuracy or completeness of such information, and all responsibility for the accuracy and completeness thereof is expressly disclaimed.
 - 2. Utility service connections are generally shown on the Drawings, but the CONTRACTOR shall be solely responsible for locating all existing underground installations, including service connections, in advance of excavating or trenching, by contacting the owners thereof and prospecting. The CONTRACTOR shall use his own information and shall not rely solely upon information shown on the drawings concerning existing underground installations. The CONTRACTOR shall protect utilities during excavation and repair all damage to existing utilities or property to the satisfaction of the utility owner or property owner at his own expense.
 - 3. If any existing underground utility or facility not shown on the drawings is located so that it interferes with the work and has to be moved or otherwise modified, such work shall be done by the CONTRACTOR, and adjustment in payment will be made according to the GENERAL CONDITIONS. Except as stated above, any delay, additional work or extra cost to the CONTRACTOR caused by existing underground installation shall not constitute a claim for extra work, additional payment, or damages.
 - 4. Temporary service shall be provided by the CONTRACTOR during any period when utility lines are disturbed unless the CONTRACTOR makes other arrangements with the utility users and of existing utility lines, if interrupted, shall be restored as quickly as possible. Do not interrupt existing utility services without written permission from ENGINEER.
 - 5. The CONTRACTOR shall coordinate with the utility companies for the protection or adjustment of existing utilities in the vicinity of the work and shall have utility company representatives present when necessary to support utility poles or buried utility lines while working adjacent to such utilities. The CONTRACTOR shall pay all costs associated with having utility company representatives on the site for this work and shall include these costs in the price bid for related items of work. Utility contact numbers include but may not be limited to the following:
 - a. Power and Telephone: Alaska Power and Telephone, Inc.
- 1.7 PROTECTION OF EXISTING STRUCTURES

- A. Where construction will be required adjacent to existing structures, the CONTRACTOR shall be solely responsible to maintain the structural integrity of the existing structures. The CONTRACTOR shall take whatever means necessary to ensure that the existing structure is not damaged and, if necessary, shall install shoring or sheet piling or change the size or type of construction equipment. The CONTRACTOR shall repair all damage to the existing structures at his own expense. Any fences destroyed during construction shall be repaired to the satisfaction of the OWNER. Any delay, additional work, or extra cost to the CONTRACTOR caused by existing underground installations shall not constitute a claim for extra work, additional payment or damages. Unless otherwise noted on the Construction Drawings, all existing ditches disturbed by construction shall be restored to their original size, line, and grade.
- B. Field Check of Existing Structures
 - 1. The dimensions and elevations of existing structures and locations of existing fences, pipelines, conduits, cables, and equipment shown on the drawings were taken for the most part from available records and survey data and are not guaranteed for accuracy.
 - 2. It shall be the responsibility of the CONTRACTOR to check all dimensions and elevations of existing structures, pipelines, conduits, cables, equipment, or other existing items, both above and below ground, affected by or affecting the Work under this contract, prior to the start of construction or ordering materials and equipment affected thereby.
 - 3. The CONTRACTOR's attention is directed to the Instructions to Bidders which recommends that each bidder visit the site of the Work to familiarize himself with the arrangement and condition of existing construction that is to be connected to or that is to remain in place.

1.8 TEMPORARY CONNECTIONS

- A. Making connections to existing facilities or other operations that interfere with the operation of the existing equipment shall be thoroughly planned in advance, and required equipment, materials, and labor shall be on hand at the time of undertaking the connections. WORK shall be completed as quickly as possible and with as little delay as possible and shall proceed continuously (24 hours a day and seven days a week) if necessary to complete modifications and/or connections in the minimum time.
- B. The cost of any temporary facilities shall be included in the WORK.
- C. Temporary facilities and piping shall be located to minimize interference with CONTRACTOR's construction facilities and OWNER's operation and maintenance of the wastewater treatment plant. Unless otherwise indicated, each temporary pipeline shall be of the same size as its connection to the existing or permanent facility at the downstream end of the pipeline. Piping materials shall be suitable for the material being conveyed and be as required in the Contract Specifications.

1.9 WORK RESTRICTIONS

A. Work Restrictions, 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: Limit work at the project site to normal business working hours of 7 a.m. to 6 p.m., Monday through Friday, unless otherwise indicated and/or approved.
 - 1. Weekend Hours: Upon approval of Owner.

1.10 EXISTING UTILITY INTERRUPTIONS:

- A. Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after providing temporary utility services according to requirements indicated:
- B. Notify Owner and Engineer not less than two days in advance of proposed utility interruptions.
- C. Obtain Owner's and Engineer's written permission before proceeding with utility interruptions.

1.11 ENVIRONMENTAL CONTROLS

- A. Noise, Vibration, and Odors: Coordinate operations that may result in high levels of noise and vibration, odors, or other disruption to Owner occupancy with Owner.
- B. Nonsmoking Building: Smoking is not permitted within the new buildings or within 25 feet of entrances, operable windows, or outdoor-air intakes.
- C. Keep project neat, orderly, and in a safe condition at all times.
- D. The CONTRACTOR shall sweep paved areas and water unpaved dry areas as deemed necessary by the ENGINEER to control soil and dust.
- E. CONTRACTOR shall dispose of all oil and petroleum products in an appropriate manner off-site. This requirement shall include any and all materials used for clean-up of such materials.
- F. Working Hours and Noise Restriction. To minimize construction noise impacts on the local residents, no construction activities will be allowed between the hours of 7:00 p.m. and 7:00 a.m., unless explicitly allowed by the ENGINEER in writing.
- G. Adverse Weather Conditions. Should adverse weather require a shutdown of the work by the OWNER or the CONTRACTOR, CONTRACTOR shall be responsible for any and all costs associated with the shutdown including but not limited to periodic road maintenance during shutdown period, demobilization, remobilization, and lost overhead and profit to the CONTRACTOR and any subcontractors.

1.12 TEMPORARY CONTROLS

A. General. Temporary service shall be provided by the CONTRACTOR during any period when utility lines are disturbed unless the CONTRACTOR makes other arrangements

with the utility users and owners that are satisfactory to said users and owners. Service of existing utility lines, if interrupted, shall be restored as quickly as possible.

1.13 RECORD DRAWINGS

- A. General The CONTRACTOR's superintendent or his designated representative shall maintain, at the project site, a "Record Set of Drawings" showing field changes, as built elevations, unusual conditions and utilities encountered during construction, dimensions to exposed features both for depth below finished grade and horizontal distance from a permanent surface feature, manufacturer's catalog number of equipment supplied, and other data as required to provide the OWNER with an accurate "as constructed" set of Drawings. Record drawings shall be maintained on a full size plan set in a neat and legible condition. Drawing set shall not be used for construction purposes and shall be available for review by the Resident Project Representative at the job site during normal working hours.
 - 1. Markings: Use red erasable colored pencils to annotate record drawings.
 - 2. Review for Progress Payments. Prior to approval of each successive Progress Payment, CONTRACTOR will be asked to update and present the record drawing set to the ENGINEER or ENGINEER's field representative prior to ENGINEER approving the pay request. An approval by the ENGINEER shall not be given on the final payment request until complete record drawings are submitted to the ENGINEER. Final record drawings from the CONTRACTOR shall be submitted at least 7 days before the final progress payment to allow time to review the drawing for completeness. Failure to submit record drawings in a timely manner, as described, may delay approval of final progress payment.

PART 2 -- PRODUCTS

2.1 NOT USED

PART 3 -- EXECUTION

3.1 NOT USED

- END OF SECTION -

SECTION 012000 – PRICE AND PAYMENT PROCEDURES

PART 1 -- GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1.3 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.
- B. The total bid price for each item of the contract shall cover all work shown on the contract drawings and required by the specifications and other Contract Documents. All costs in connection with the work, including furnishing all materials, equipment, supplies and appurtenances; providing all construction plant, equipment, and tools; and performing all necessary labor and supervision to fully complete the Work, shall be included in the unit and lump sum prices bid. No item that is required by the Contract Documents for the proper and successful completion of the Work will be paid for outside of or in addition to the prices submitted in the bid. All work not specifically set forth as a pay item in the Bid Form shall be considered a subsidiary obligation of the CONTRACTOR and all costs in connection therewith shall be included in the prices bid.

1.4 ESTIMATED QUANTITIES

- A. All estimated quantities for unit price items to be paid per field measurement as stipulated in the Bid Form or other Contract Documents are approximate and are to be used only (a) as a basis for estimating the probable cost of the Work and (b) for the purpose of comparing the bids submitted for the Work. The actual amounts of work done and materials furnished under unit price items may differ from the estimated quantities. The basis of payment for work and materials will be the actual amount of work done and materials furnished and accepted. The CONTRACTOR agrees that he will make no claim for damages, anticipated profits, or otherwise on account of any difference between the amount of work actually performed and materials actually furnished and the estimated amounts herein except as follows.
- B. Either the OWNER or the CONTRACTOR may demand in writing that a supplemental agreement or change order be prepared to authorize an adjustment in the unit price of any MAJOR CONTRACT item if the quantity of said MAJOR CONTRACT item increases or decreases by more than 25 percent from that shown in the Contract Documents. A MAJOR CONTRACT item is defined as any item having an original contract value in excess of 10 percent of the total original contract.

C. If one of the bid items described in the Schedule of Values of this section is not included in a particular schedule or zone on the Bid Form but measurement and payment for that item is required according to the drawings and/or by the ENGINEER, the unit price from a similar schedule or zone will be used to establish the unit price for that item in the other schedule or zone.

1.5 AUTHORITY

A. The ENGINEER will perform all measurements and compute quantities for payment. The ENGINEER will verify measurements and quantities provided by the CONTRACTOR. The CONTRACTOR shall provide ENGINEER access to work areas for survey measurements, as required.

1.6 NON-PAYMENT ITEMS

- A. Separate or specific payment will not be made for certain items, including but not limited to:
 - 1. Wasted products.
 - 2. Products that are wasted, disposed of, or otherwise handled in an unacceptable manner.
 - 3. Products determined to be unacceptable in the opinion of the ENGINEER, before or after placement.
 - 4. Products not completely unloaded from the transporting vehicle.
 - 5. Products placed beyond the lines and grades of the required work.
 - 6. Products remaining on hand after completion of the work.
 - 7. Loading, hauling, and disposing of rejected products.
 - 8. Concrete that is delivered without a batch ticket or with a ticket that does not show actual batch weights, aggregate absorption, and aggregate-moisture content.
 - 9. Overly wet, overly dry, or frozen-earth material.
 - 10. Excavation or fill made for the convenience of the CONTRACTOR.
 - 11. Over excavation and backfill of over excavation.
 - 12. Work performed that has been rejected and/or determined to be defective.

1.7 MEASURED QUANTITIES

- A. Measurement by Volume: Measured by cubic dimension using mean length, width, and height or thickness.
- B. Measurement for payment of excavations upon or against which concrete is not to be placed will be limited to the lines and grades shown on the Drawings or to the most

practical lines, grades, and dimensions established by the ENGINEER, in writing. No measurement will be made of over excavations beyond design lines and grades.

- C. No measurement for payment will be made for additional concrete that results from subgrade surface irregularities. Such additional concrete is considered incidental and therefore included in the Contract price for the applicable item.
- D. Fill quantities will be computed using the average-end-area method or other computation method approved of by the ENGINEER.
- E. Measurement by Area: Measured by square dimension using mean length and width or radius. Items that are measured by area will be measured parallel to the ground surface.
- F. Linear Measurement: Measured by linear dimension at the item centerline or mean chord. Items that are measured by the lineal foot, such as pipe, will be measured parallel to the ground surface, unless otherwise specified.
- G. Stipulated Sum/Price Items: Measured by weight, volume, area, or linear means, or combination, as appropriate, as completed items or units of the work.
- H. Lump-Sum Items: Will not be measured for payment. However, measurements may be made to monitor work progress.

1.8 SCHEDULE OF VALUES

- A. A schedule of values or "allocation of contract price" is required for major lump sum items. The schedule of values is used only to help assess the intermediate value of work completed for the purpose of making progress payments.
 - 1. 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.
 - 2. Temporary facilities and other major cost items that are not direct cost of actual workin-place may be shown either as separate line items in the schedule of values or distributed as general overhead expense, at Contractor's option.
 - 3. The schedule of values is included as Attachment A to this specification.

1.9 MEASUREMENT AND PAYMENT ITEMS

- A. Measurement: Shall be by percent or work completed for Lump Sum Items or by unit price as specified in the Schedule of Values.
- B. Payment: Payment for this item shall be made based on percent of work completed compared to the Contractor-furnished and Engineer approved Schedule of Values.

PART 1 - PRODUCTS (Not Used)

PART 2 - EXECUTION (Not Used)

- END OF SECTION -

Schedule of Values

Item	Description	units	quantity	Unit Price	Total
Schedule B	Wastewater Plant UV Disinfection Project		Schedule B1 and B2 Subtotal =		
B1.0	UV Disinfection Project General Conditions			B1 Subtotal =	
B1.1	Superintendent	еа	1		
B1.2	Housing and travel	ls	1		
B1.3	Material Procurement*	ls	Included in the itemized costs		
B1.4	Equipment mobilization*	ls	1		
B1.5	Engineering and Quality Control*	ea	1		
B1.6	Safety planning and equipment*	еа	1		

B2.0	UV Disinfection			B2 Subtotal =	
B2.1	Complete demolition of chlorine contact basin elements per the plans - - Remove the broad crested weir, portion of hand rail, telescoping	ls	1		
B2.1	Construct tee and valving from the extended aeration line that enters the contact basin. Run the pipe to the new UV bank channel through	ls	1		
B2.2	Complete steel work including W10x22 I beam, framing for the steel grating, etc.	ls	1		
B2.3	Raise the UV Channel floor with clean gravel and a new reinforced concrete floor. Construct new reinforced concrete UV channel walls.	ls	1		
B2.4	Construct the pad for hoist and UV related equipment. Install the hoist.	ls	1		
B2.5	Install remaining steel works pipe support, grated platform, stairs, stair rails.	ls	1		
B2.6	Install the extended aeration liquid supply piping, support frame work, and associated type I and II wall penetrations.	ls	1		
B2.7	Install the owner furnished Glasco UV Equipment Includes 2 each UV units, level control weir, and air compressor.	ls	1		
B2.8	Install new circuits and breakers in the Panel LM. Install Buck-boost transformer. Install Sensaphone.	ls	1		

Schedule of Values

ltem	Description	units	quantity	Unit Price	Total
B2.9	Install buried power and control wire to the UV Control Panel. Wire the Flow Meter, Float Switch, and UV Units.	ls	1		
B2.10	Inspect the installation. Startup the UV system with the Engineer and Glasco representative.				
B2.11					

	Additive Alternate				
B3.0	Wastewater Plant Back Up Power Generator		Additive Alternate B3 Subtotal =		
B3.1	Construct Generator Pad. Place the new generator.	ls	1		
B3.2	Install emergency power and control circuits and normal power circuits to the Automatic transfer switch	ls	1		
B3.3	Install Automomatic Transfer Switch	ls	1		
B3.4	Relocate outside lighting panel to accommodate the ATS.	ls	1		
B3.5	Route Feeder from ATS to HDMP	ls	1		
B3.6	Inspect and test by others including Engineer				

Schedule B1 and B2 Subtotal =

Additive Alternate B3 Subtotal =

Total Schedule B and additive alternate(s) =

SECTION 013300 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 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.

1.2 SUMMARY

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

1.3 DEFINITIONS

- A. Shop Drawings: All drawings, diagrams, illustrations, schedules and other data which are specifically prepared by or for CONTRACTOR to illustrate some portion of the work and all illustrations, brochures, standard schedules, performance charts, instructions, diagrams, and other information prepared by a supplier and submitted by CONTRACTOR to illustrate material or equipment for some portion of the work.
- B. Sample: Physical examples of materials, equipment, or workmanship that are representative of some portion of the Work and which establish the standards by which such portion of the work will be judged.
- C. CONTRACTOR's Review and Approval: The Standard General Conditions (EJCDC No. C-700) identifies the CONTRACTOR's obligations in respect to the submittal, review, and approval of Shop Drawings and Samples. CONTRACTOR shall satisfy CONTRACTOR's obligations with respect to review and approval per the Standard General Conditions and the requirements of this section (013300).
- D. ENGINEER's Review and Approval: The Standard General Conditions (EJCDC No. C-700) identifies the ENGINEER's obligations in respect to review and approval of shop drawings and samples. ENGINEER's review and approval will be only to determine if the items covered by the submittals will, after installation or incorporation in the Work, conform to the information given in the Contract Documents and be compatible with the design concept of the completed project as a functioning whole as indicated by the Contract Documents.

PART 2 - PRODUCTS

None

PART 3 - EXECUTION

3.1 SUBMITTAL PROCEDURE:

- A. Shop Drawings shall be submitted as specified in the Standard General Conditions. In addition, Shop Drawings, Progress Pay Estimates, Closeout Documents, and all other project submittals shall be submitted as follows:
 - 1. ENGINEER will establish an electronic submittal registry for this project through Submittal Exchange (<u>http://www.submittalexchange.com/public/</u>), or NewForma Info Exchange. These are electronic submittal registry programs.
 - 2. In accordance with the Standard General Conditions, CONTRACTOR shall submit and receive approval of a schedule of shop drawings and sample submittals which will list each required submittal and the times for submitting, reviewing and processing such submittal.
 - 3. Date and Number: At least 30 days prior to CONTRACTOR's need for approval, CONTRACTOR shall electronically submit for approval, the requisite shop drawings and sample submittals. Paper copies will not be accepted. As part of the ENGINEER's account with Submittal Exchange, CONTRACTOR, Subcontractors and vendors will be provided access to Submittal Exchange free of charge throughout the duration of the project. In addition, ENGINEER has secured and paid for training sessions with CONTRACTOR and his team for use of Submittal Exchange.
 - 4. In general, CONTRACTOR will upload the submittals to a pre-established portal identifying the project and the portion of the project to which it applies. All appropriate information shall be filled out and a listing of all variances from the contract documents shall be included.
 - 5. Transmittal Form: All submittals shall be forwarded with a signed copy of the "TRANSMITTAL OF SHOP DRAWINGS" form attached at the end of this section, or similar, identifying the project and the portion of the project to which it applies. All appropriate information included on the transmittal form shall be filled out and a listing of all variances from the contract documents shall be included. Each transmittal form shall be signed by an individual authorized to do so, as a certification that the CONTRACTOR's responsibilities with respect to review and submission of the shop drawings have been satisfied.
 - 6. Submittals that are related to or affect each other shall be forwarded simultaneously as a package to facilitate a coordinated review. Uncoordinated submittals will be rejected.

- 7. Submittal Exchange will log and coordinate the uploaded information in a preestablished submittal registry. E-mail notifications are then forwarded to the ENGINEER and the respective responsible reviewers. Each reviewer will be responsible for checking out the submittal, reviewing electronically and providing response as required. The reviewer then will re-post the reviewed package with appropriate notation and action to be taken. E-mail notifications are then forwarded to the CONTRACTOR regarding status of the submittal. All electronic file uploads will be in pdf format.
- B. CONTRACTOR's Stamp:
 - 1. All Shop Drawings and Samples are required to be submitted by the General Contractor and they shall bear a stamp or specific written indication directly on the submittal that confirms that the CONTRACTOR has satisfied all CONTRACTOR's responsibilities under the Contract Documents. ENGINEER will not accept shop drawings from anyone outside of the Prime Contractor or shop drawings that do not contain a stamp or other written indication on them that states that the CONTRACTOR has satisfied his responsibilities per the Contract Documents.
 - 2. The ENGINEER's review and approval shall not relieve the CONTRACTOR from responsibility for any variation from the requirements of the Contract Documents unless CONTRACTOR has in writing called ENGINEER's attention to each variation at the time of submission and ENGINEER has given written approval.
- C. ENGINEER'S APPROVAL:
 - 1. The ENGINEER will indicate his approval or disapproval of each submittal and, if he does not approve the submittal as submitted, will indicate his reasons therefor. Any work done prior to approval shall be at the CONTRACTOR's own risk. Approvals shall not relieve the CONTRACTOR from responsibility for complying with the requirements of this Contract. If submittals show variations from the Contract requirements, the CONTRACTOR shall describe such variations in writing, within the before mentioned cover letter at the time of submission. Approval of such variation(s) shall be accompanied with a Contract Modification. Minor variations not involving a change in price or time of performance will not be issued a modification.
- D. REQUIRED SUBMITTALS:
 - 1. Permits: Submit to the ENGINEER at the preconstruction conference a copy of all permits required by the governing authorities.
 - 2. Subcontractors: At the Preconstruction Conference, the CONTRACTOR shall supply a list of all suppliers and subcontractors to be used on the project.
 - 3. Equipment List and Rental Rates: At the preconstruction conference, the CONTRACTOR shall supply a list of all equipment owned or rented that will be used on this project. The equipment list shall include the make, model, year, horsepower and capacity of each piece of equipment. The list shall also include rental rates and operating rates for each piece of equipment determined per the requirements of these contract documents.
 - 4. Certificates: For those items called for in individual sections, furnish certificates from manufacturers, suppliers, or others certifying that materials or equipment

being furnished under the Contract comply with the requirements of these specifications.

- 5. Shop Drawings: See the individual sections for specific requirements.
- 6. Progress Schedule and Schedule of Values: The CONTRACTOR shall submit to the OWNER with the completed Agreement a Progress Schedule, Schedule of Values, and an estimated Progress Payment Schedule. The Progress Schedule shall be in bar chart or Critical Path Method (CPM) form and show estimated starting and completion dates for each part of the Work. The Progress Payment Schedule shall show the monthly progress payment requests that are estimated to be made through the duration of the Contract. Both the Progress Schedule and Payment Schedule shall be revised monthly to show project progress revisions to the schedules. The revised schedules shall be submitted with the monthly progress payment request. No monthly progress payment request shall be accepted from the CONTRACTOR and processed for payment unless accompanied by the revised schedules.
- 7. Operation and Maintenance Instructions: Manufacturer's printed instructions shall include installation instructions, operating instructions, maintenance literature, lubrication requirements, and parts lists.
- 8. Quality Control Plan: The CONTRACTOR shall submit his Quality Control Plan defining the program and documentation proposed ensure that all materials and work conform to the Contract Documents. The plan shall identify personnel, procedures, control, tests, frequency of tests, and records and forms to be used. The CONTRACTOR shall not commence work on any items requiring quality control until his plan is reviewed by the ENGINEER, and all deficiencies in the plan noted by ENGINEER have been corrected.

END OF SECTION 013300



SUBMITTAL REVIEW TRANSMITTAL

Project Name: Thorne Bay Wa	Submittal No (Spec Section)-(Series)	
Project Owner: City of Thorne I	Date Received:	
Contractor:	Engineer: DOWL	Engineer Project No.
Address:	Address:	Specification Section:
Attn:	Attn:	1 st Submittal:
Transmittal Date:	Previous Transmittal Date:	Re-Submittal:

DOWL SUBMITTAL REVIEW

ENGINEER'S review and approval of this submittal are expressly limited as provided in the Contract Documents and are only to determine conformance with information given in Contract Documents and compatibility with design concept of completed project as a functioning whole as indicated in the Contract Documents. CONTRACTOR is, and ENGINEER is NOT responsible for all matters relating to fabrication, shipping, handling, storage, assembly, installation, construction (including all safety aspects of performing the Work), and for coordinating the Work.

ltem #	Description	Manufacturer/Vendor	Action

Action Legend ANEN – Approved, No Exceptions Noted AN – Approved as Noted RR – Revise and Resubmit R - Rejected I/O - Informational

Remarks/Comments:

Reviewed By: ____ Review Date: ____

SECTION 014500 - QUALITY CONTROL

PART 1 - GENERAL

1.1 DESCRIPTION:

This section describes the CONTRACTOR's "Quality Control" requirements and OWNER's "Quality Assurance" program.

1.2 DEFINITIONS:

- A. Quality Control: Planned and specific actions or operations necessary to produce a product that complies with the Contract Documents. Quality Control consists of actions, inspections, sampling and testing necessary to ensure the Work is in compliance with the Contract Documents and to control production and construction processes. Quality Control is keyed to the construction sequence to quickly determine when the Work is out of compliance with the Contract Documents and to respond to correct the situation and bring the Work into compliance. Quality Control is the responsibility of the CONTRACTOR.
- B. Quality Assurance: Planned and systematic observations, testing and actions to verify that the Work complies with the Contract Documents. Quality Assurance includes oversight of the CONTRACTOR's Quality Control, verifying the results of the CONTRACTOR's testing and additional assurance sampling and testing. Quality Assurance may not be adequate for the CONTRACTOR's production and placement needs. The OWNER or ENGINEER will provide Quality Assurance.
- C. Verification/Compliance Testing: Sampling and testing which is carried out independent of the CONTRACTOR's Quality Control testing to confirm/verify that the Work complies with the Contract Documents. The frequency of verification/compliance testing will be determined by the OWNER and may not be adequate for the CONTRACTOR's production and placement needs. Verification/compliance testing will not be used to determine construction procedures or operations (i.e. rolling patterns, lift thickness, etc.). Verification/compliance testing will be provided by the OWNER and /or ENGINEER.

1.3 SUBMITTALS:

- A. Quality Control Plan: At the preconstruction conference, the CONTRACTOR shall submit a Quality Control Plan defining the program and the documentation proposed to ensure that all materials and work conform to the Contract Documents. The plan shall identify personnel, procedures, control, tests, frequency of tests, and records and forms to be used.
- B. Test Records: CONTRACTOR shall submit records of all tests to the ENGINEER within 24 hours of the testing. The Quality Control laboratory shall notify the CONTRACTOR and ENGINEER promptly of irregularities or deficiencies observed in the Work during performance of the Quality Control Testing.

QUALITY CONTROL ISSUED FOR CONSTRUCTION PAGE 014500 - 1 MARCH 2018

PART 2 - PRODUCTS

NONE

PART 3 - EXECUTION

3.1 GENERAL:

- A. Coordination: CONTRACTOR shall be responsible for Quality Control tests and inspections to control production and construction processes. Include in the CONTRACTOR Quality Control system an internal organization, plans, and procedures to produce the specified end product. Assure the system covers all construction operations, both on-site and off-site, and is keyed to the construction sequence.
- B. Construction Testing: Quality Control testing frequency is at the CONTRACTOR's discretion, except where tests are specifically required in the technical specifications for individual products and as follows.
 - 1. <u>Field Density</u>: Quality Control density testing will be completed on all trenches, structural backfill, and on all improved surfaces/roadways crossings.
 - a. Field density tests of compacted backfill and gravel base course shall be performed at all levels and elevations, as noted.
 - b. Density tests performed to establish rolling patterns shall not be considered as testing to meet the minimum frequency.
 - c. Paved and Building Slab Areas: At subgrade and each 12" of compacted fill and backfill layer, at least one test for every 2,000 sq. ft. or less of paved area or building slab, but in no case fewer than three tests.
 - 2. Steel Reinforcement Placement: See Section 033000
 - 3. Concrete Tests: See Section 033000
 - 4. Quality Assurance testing frequency is at the ENGINEER's discretion.
- C. Laboratory: The Quality Control tests are to be performed by an approved independent testing laboratory at the expense of the CONTRACTOR. Locations for testing shall be determined at random by the independent testing laboratory personnel. The method for selecting random locations shall be as established in the Quality Control Plan.

3.2 CONTRACTOR COOPERATION WITH QUALITY ASSURANCE AGENCY:

A. Access: CONTRACTOR shall assure that the OWNER's personnel and Quality Assurance agency has access to all work areas at all times work is in progress.

QUALITY CONTROL ISSUED FOR CONSTRUCTION PAGE 014500 - 2 MARCH 2018 Provide any special facilities or equipment to access work areas at the CONTRACTOR's expense.

- B. Notification: CONTRACTOR shall notify the ENGINEER when the work is ready for Quality Assurance testing. Establish and update the construction schedule to provide the ENGINEER estimated sampling/testing dates and times.
- C. Samples: All samples obtained for the purpose of determining a Proctor value for use in Quality Control must be split, and half of the sample shall provided to the ENGINEER. If a sample is obtained and the ENGINEER is not provided with a split of the material, the test results of the material in question will be unacceptable. CONTRACTOR shall provide adequate notice to the ENGINEER's representative so that they may be present to collect the sample.

3.3 PAYMENT FOR TESTING:

- A. CONTRACTOR's Cost: All Quality Control testing costs are incidental to the work and to be included in the CONTRACTOR's bid. Mix designs for Portland cement concrete, flowable fill, and asphalt concrete, and all initial aggregate quality tests are considered Quality Control tests and are at the CONTRACTOR's expense.
- B. OWNER's Cost: OWNER will pay for all Quality Assurance testing costs.
- C. Retesting: Quality Assurance retesting due to failing initial tests will be performed by the OWNER or the OWNER's Quality Assurance testing agency, and the retest costs will be deducted from the CONTRACTOR's progress estimates.

END OF SECTION 014500

PART 1 -- GENERAL

1.1 GENERAL

- A. Satisfactory testing and startup of new and modified facilities are prerequisites to successful completion of the contract requirements and shall be completed within the Contract Times.
- B. Conduct all testing, check-out, startup, and related requirements indicated in the Contract Documents and provide documentation of same to the ENGINEER prior to requesting Substantial Completion from the ENGINEER. Where manufacturer onsite inspections are required before startup, the manufacturer shall furnish a written statement that the installation and check-out are complete and proper and that the item(s) are ready for startup.
- C. Startup of the treatment plant will require the combined expertise of the CONTRACTOR, subcontractors, UV System Supplier, ENGINEER, and OWNER. The CONTRACTOR shall be responsible for coordinating all parties for a successful startup: the ENGINEER and OWNER will be available for technical and operational advice prior to and during startup.
- D. General requirements for startup activities are included in this Section. More specific requirements may also be included in other portions of the Contract Documents.
- E. Temporary facilities may be necessary. If so, CONTRACTOR shall design, provide, operate, and later decommission them.

1.2 DEFINITIONS

- A. Startup is defined as testing, demonstrations, and other activities as required to achieve Substantial Completion. Startup includes pre-commissioning and commissioning activities, manufacturer's services, certifications of readiness for testing, and troubleshooting, checkout, and shakedown activities.
- B. Pre-commissioning is the systematic demonstration through testing and extended operation that major equipment and auxiliary systems, including related components, sub-systems, and systems operate properly and consistent with their intended function.
 - Pre-commissioning shall simulate shutdown conditions, failure conditions, power fail and restart, bypass conditions, and failure resets. Pre-commissioning will not be considered complete until successful results and documentation of tests and manufacturer's certifications required by the Contract Documents are submitted and accepted by the ENGINEER. Pre-commissioning of all portions of the WORK shall be successfully completed prior to starting Commissioning.
- C. Commissioning is the verification that the complete WORK functions on an extended basis in full conformance with the Contract requirements.

1.3 SUBMITTALS

- A. **Schedule:** The schedule for startup shall be submitted in addition to the CONTRACTOR's overall CPM Construction Schedule.
- B. **Startup and Commissioning Plan:** Not less than 30 Days prior to startup, submit for review a detailed Startup and Commissioning Plan. The CONTRACTOR shall revise the Plan as necessary based on review comments. The Plan shall include:
 - 1. Schedules for manufacturers' equipment certifications
 - 2. Schedules for submitting final Technical Manuals
 - 3. Schedule for training the OWNER's personnel
 - 4. Description of temporary facilities and schedule for installation and decommissioning them
 - 5. List of OWNER and CONTRACTOR-furnished supplies
 - 6. Detailed schedule of operations to achieve successful pre-commissioning and commissioning.
 - 7. Checklists and data forms for each item of equipment
 - 8. Coordination with the OWNER's staff and UV Supplier's staff
 - 9. Designation of a representative of the CONTRACTOR who has the authority to act in matters relating to startup and has experience in testing and startup.
 - 10. Designation of the roles and responsibilities of any Subcontractors that may be involved in startup activities.
 - 11. Safety, startup, and testing procedures.
 - 12. Proposed inspection and certification forms and records.
 - 13. Interconnection of new to existing facilities
 - a. Date and time frame of proposed shutdown or interconnection, including sequence of events and activities to be conducted.
 - b. A detailed description of sequences and activities for the planned shutdown and interconnection.
 - c. Staff, equipment, and materials that will be at the Site before commencing the shutdown.
 - d. Other provisions so that interconnection, testing, and startup will be completed within the planned time
 - 14. Hydrostatic testing of water-holding structures and pipelines and other potable (If applicable) water equipment. Schedule and plan shall indicate source of water, testing and disinfection sequence, disinfection procedures, and the disposal of the water following disinfection, if applicable.

STARTUP OF SYSTEMS/COMMISSIONING ISSUED FOR CONSTRUCTION

- C. **System Outage Requests:** Request for shutdown of existing systems as necessary to test or start up new facilities.
- D. Records and Documentation
 - 1. Where required by the specifications, submit equipment installation certifications under those Sections.
 - 2. Records of startup as indicated below.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION

- 3.1 GENERAL
 - A. Supplies
 - 1. The CONTRACTOR shall furnish:
 - a. Necessary materials not listed for the OWNER to furnish
 - b. Power
 - 1) Temporary power provisions shall be provided by the Contractor

2) Power and heating costs for operation of the treatment equipment and lighting, heating, ventilation of buildings will be responsibility of Contractor until substantial completion.

- B. **Startup Records:** The CONTRACTOR shall maintain the following during testing and startup and submit originals to ENGINEER:
 - 1. Lubrication and service records for each mechanical and electrical equipment item.
 - 2. Hours of daily operation for each mechanical and electrical equipment item.
 - 3. Equipment alignment and vibration measurement records.
 - 4. Logs of electrical measurements and tests.
 - 5. Instrumentation calibration and testing logs.
 - 6. Testing and validation of inputs, outputs, logic functions, status indications, and alarms.
 - 7. Factory and field equipment settings.
 - 8. Log of problems encountered and remedial action taken.
 - 9. Other records, logs, and checklists as required by the Contract Documents.

3.2 MALFUNCTIONS

- A. During the extended operational demonstrations, all components, subsystems, systems, and equipment must properly run continuously 24 hours per day at rates indicated by the ENGINEER throughout the test period. Unless indicated otherwise, if any item fails or malfunctions during the test, the item shall be repaired and the test restarted at time zero with no credit given for the operating time before the failure or malfunction. Malfunctions satisfying all three of the following conditions will allow the demonstration period to resume at the elapsed time when the malfunction started:
 - 1. Malfunction did not cause any interruption of the continuous operation of any other components, subsystems, systems, and equipment.
 - 2. Malfunction was corrected without causing or requiring any components, subsystems, systems, and equipment to cease operations.
 - 3. Malfunction was corrected within one hour of the time the malfunction was detected (the one hour period includes the time required to locate the cause of the malfunction, beginning upon CONTRACTOR's notification from the ENGINEER that a malfunction has occurred and ending when the item is corrected and the system is successfully placed back into operation).
- B. The CONTRACTOR shall arrange for manufacturer's representatives to visit the Site as often as necessary to correct malfunctions.

3.3 PREREQUISITES

- A. Pre-commissioning and commissioning activities shall be scheduled according to CPM Construction Schedule protocols. The following shall be completed before pre-commissioning begins.
 - 1. All Technical Manual information required by the Contract Documents has been submitted.
 - 2. Safety equipment, emergency shower and eyewash units, fire extinguishers, gas detectors, protective guards and shields, emergency repair kits, safety chains, handrails, gratings, safety signs, and valve and piping identification required by the Contract Documents are provided. Devices and equipment shall be fully functional, adjusted, and tested.
 - 3. Electrical tests, balancing, and adjustments have been completed.
 - 4. The ENGINEER has approved the Startup Plan.
 - 5. Temporary facilities are functional, adjusted, and ready for use.
 - 6. Individual instrumentation loops (analog, status, alarm, and control) have been verified functionally.
 - 7. Individual interlocks between the field-mounted control devices and the motor control circuits, control circuits of variable-speed controllers, and packaged system controls have been verified.

3.4 PRE-COMMISSIONING

- A. The Contractor shall complete a pre-commissioning to test all functionality, operation and alarms on equipment installed.
- B. After individual equipment items and subsystems have been tested and certified as required by the Technical Specifications, tests of systems comprised of single or multiple equipment items with appurtenant equipment and instruments and controls shall be conducted. Items of equipment shall be tested as part of a system to the maximum extent possible.
- C. The CONTRACTOR shall furnish the ENGINEER at least 10 Days written notice confirming the start of pre-commissioning. The OWNER's staff will observe pre-commissioning.
- D. If any system malfunctions, the item or equipment shall be repaired and the test restarted at time zero with no credit given for the elapsed time before the malfunction.
- E. The CONTRACTOR shall demonstrate the manual and automatic modes of operation to verify proper control sequences, proper operation of software logic and controllers, etc.
- F. Systems testing activities shall follow the detailed procedures and checklists in the Testing and Startup Plan. Completion of systems shall be documented by a report.
- G. The CONTRACTOR shall demonstrate utility, chemical feed, safety equipment, and other support systems before whole process systems.

3.5 COMMISSIONING

- A. Testing periods shall not include holidays, based on the OWNER's calendar.
- B. The CONTRACTOR shall start up the plant and operate it without malfunction for a continuous 2 Day, 24 hour/day period. The ENGINEER will determine the operational parameters. If any equipment item, subsystem, or system malfunctions, the item or equipment shall be repaired and the test restarted at time zero with no credit given for the elapsed time before the malfunction.
 - 1. A total of 14 days (2 weeks) is allotted in the project schedule for the commissioning phase and accounted for in the time allowance to achieve substantial completion.
- C. The CONTRACTOR shall furnish the ENGINEER at least 10 Days written notice confirming the start of commissioning. The OWNER's staff will observe commissioning.
- D. Defects that appear shall be promptly corrected. Time lost for wiring corrections, control point settings, or other reasons that interrupt the test may, at the judgment of the ENGINEER, be cause for extending the demonstration an equal amount of time.
- E. The CONTRACTOR shall furnish the services of manufacturers' representatives, if necessary, to correct equipment malfunctions and assist with the commissioning demonstration.
- F. The OWNER will furnish plant operators during the startup period to comply with requirements for discharging water. Certified operators will be under the direct

supervision of and be responsible to the OWNER but will operate the plant in accordance with the Startup and Commissioning Plan.

- G. During the commissioning demonstration, the CONTRACTOR shall:
 - 1. Lubricate and maintain equipment in accordance with the manufacturers' recommendations.
 - 2. Perform other activities needed to maintain proper operation of the equipment and systems.

END OF SECTION 017500

SECTION 017700 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 DESCRIPTION:

The following specification includes all work involved in final closeout of this Project. Included are items such as post construction inspection, acceptance of the Work, closeout records, cleaning, and project record drawings.

1.2 RELATED WORK:

Contract General Conditions

1.3 SUBMITTALS:

All required closeout submittals shall be reviewed by the ENGINEER prior to final payment. Items to be submitted are:

- A. Guarantees and Bonds. Provide guarantees and bonds as required herein and as provided by manufacturers of all products and equipment.
- B. Certification of Completion: Certifying completion of construction, compliance with the Contract Documents, and waiver of any claims.
- C. Contractor's Affidavit of Release of Liens.
- D. Final Waiver of Lien.
- E. Consent for Surety to Final Payment:
- F. Insurance Certificate: Certificate to indicate which insurance coverages required by Contract General Conditions that are to remain in effect after project is completed.

PART 2 - PRODUCTS

None.

PART 3 - EXECUTION

3.1 CLEANING:

Sweep paved surface, including all adjacent haul streets and other incidental areas, soiled during construction. All lawn or grassed areas shall be raked and cleaned to level and remove all rocks, stones or other debris from construction.

3.2 SUBSTANTIAL COMPLETION AND FINAL INSPECTION:

Submit written certification that project, or designated portion of Project, is substantially complete and request, in writing, a final inspection. The ENGINEER, OWNER, and any representatives of funding agencies will make an inspection within 10 days of receipt of any request.

Should the ENGINEER determine that the Work is substantially complete, he will prepare a punch list of deficiencies that need to be corrected before final acceptance, and issue a Notice of Substantial Completion with the deficiencies noted.

Should the ENGINEER determine that the Work is not substantially complete, he will immediately notify the CONTRACTOR, in writing, stating reasons. After the CONTRACTOR completes the Work, he shall submit certification and request for final inspection.

3.3 ACCEPTANCE OF THE WORK:

After all deficiencies have been corrected, a Letter of Final Acceptance will be issued. If only designated portions of the project have been inspected, a Letter of Partial Acceptance will be issued for that portion corrected.

Acceptance may be given prior to correction of deficiencies which do not preclude operation and use of the facility; however, final payment will be withheld until all deficiencies are corrected. Until receipt of the Letter of Final Acceptance, the CONTRACTOR shall be responsible for the Work of this Contract.

END OF SECTION 017700

SECTION 033000 - 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 Sections:
 - 1. Section 312000 "Earth Moving" for drainage fill under slabs-on-grade.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Proposed Mix Designs: Submit in accordance with ACI 301 at least 30 calendar days prior to first-scheduled concrete placement. Provide 28-day strength data for structural concrete and 56-day strength data for mass concrete where mix was used for previous projects within the last year, or minimum 28-day strengths for a new mix. Include laboratory test results, mill test reports, or certificates of compliance for each material used in concrete mixes.
- C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Shop drawings shall comply with ACI 315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures".
- D. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer detailing fabrication, assembly, and support of formwork.
- E. Related Materials: Product data for joint materials, waterstops, admixtures, curing materials, sealants, hardeners, bonding agents and other concrete related materials that are required or proposed.

1.3 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Material certification tests and delivery certificates for Portland cement, fly ash and other cementitious admixtures.
- C. Material test reports including certification tests for water and aggregates conforming to these specifications.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
- B. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
- C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4/D 1.4M, "Structural Welding Code Reinforcing Steel."
- D. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
 - 1. ACI 301, "Specifications for Structural Concrete," Sections 1 through 5.
 - 2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials".
 - 3. ACI 302.1R, "Guide for Concrete Floor and Slab Construction".
 - 4. ACI 304R, "Guide for Measuring, Mixing, Transporting and Placing Concrete".
 - 5. ACI 304.2R, "Placing Concrete by Pumping Methods".
 - 6. ACI 305R, "Hot Weather Concreting".
 - 7. ACI 306.1 and 306R, "Cold Weather Concreting".
 - 8. ACI 308R, "Guide to Curing Concrete".
 - 9. ACI 309R, "Guide for Consolidation of Concrete".
 - 10. ACI 318R, "Building Code Requirements for Structural Concrete".
- E. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. Avoid damaging coatings on steel reinforcement; furthermore, all reinforcing steel shall be clean and free of mill scale, rust, debris and any other deleterious material prior to placement.
- B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS

- A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
- B. Chamfer Strips: Wood, metal, PVC, or rubber strips, 1 by 1 inch, minimum.
- C. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent

treatments of concrete surfaces. Interior basin and tank form coatings to comply with NSF 61 requirements for potable water.

- 1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
- D. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
 - 1. Furnish units that will leave no corrodible metal closer than 2 inch to the plane of exposed concrete surface.
 - 2. Furnish ties that, when removed, will leave holes no larger than 1 inch in diameter in concrete surface.
 - 3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.
- 2.2 STEEL REINFORCEMENT
 - A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
 - B. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, plain, fabricated from as-drawn steel wire into flat sheets.
 - C. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.
 - D. 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.

2.3 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious material, of the same type, brand, and source, throughout Project:
 - 1. Portland Cement: ASTM C 150, Type I/II.
- B. Normal-Weight Aggregates: ASTM C 33, graded.
 - 1. Maximum Coarse-Aggregate Size: 1 inch nominal.
 - 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- C. Water: ASTM C 94/C 94M and potable.
- D. Grout: Proprietary, pre-mixed, non-ferrous, non-shrink grout conforming to Corps of Engineers specification CRD-C 621.
- E. Adhesive: Use specified materials for securing dowels and fasteners to hardened concrete. Installation shall conform to the manufacturer's recommendations and instructions.

2.4 ADMIXTURES

- A. Air-Entraining Admixture: ASTM C 260.
- B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will 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/C 494M, Type A.
 - 2. Retarding Admixture: ASTM C 494/C 494M, Type B.
 - 3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
 - 4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
 - 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
 - 6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.5 WATERSTOPS

A. Flexible PVC Waterstop: CE CRD-C 572 for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes. Waterstops shall be of an approved type, supplied by an approved manufacturer and shall be plastic made of virgin polyvinylchloride compound, shall be ribbed, uniform in dimensions, dense, homogeneous, free from porosity, and as detailed on the Drawings. No reclaimed PVC shall be used in the compound.

2.6 JOINT SEALERS

- A. Joints shall be sealed with a mastic joint sealer material of uniform, stiff consistency that does not contain solvents.
- B. The mastic shall tenaciously adhere to primed concrete surfaces, shall remain permanently mastic and shall not contaminate potable water. Product must be NSF 61 approved.
- C. The material shall be of a type that will effectively and permanently seal joints subject to movements in concrete.
- D. The mastic joint sealer shall be an acceptable two-part, non-sag (or self-leveling), nonstaining, polyurethane elastomeric sealant which cures at ambient temperature. Acceptable sealants shall conform to ASTM C-920 or Federal Specification TT-S-00227E. Non-sag sealants are to be used on vertical applications while the selfleveling or non-sag sealants may be used in horizontal applications.
- E. Acceptable polyurethane materials include SIKAFLEX/1a and SIKA-FLEX/2c NS and 2c SL POLYURETHANE ELASTOMERIC SEALANT, as manufactured by SIKA CHEMICAL CORP., Santa Fe Springs, CA (213-941-0231), or approved equal.

2.7 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

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- 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.

2.8 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork.
- B. Bonding Agent: ASTM C 1059/C 1059M, Type II, non-redispersable, acrylic emulsion or styrene butadiene.
- C. 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 IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
- D. Adhesive Anchors: Hilti HIT-RE 500V3, HIT-HY150 MAX, or Simpson SET XP adhesive anchors. Install per manufacturer's recommendations.
- E. Expansion Anchors: Hilti Kwik Bolt TZ or Simpson Strong-Bolt expansion anchor. Install per manufacturer's recommendations.

2.9 CONCRETE MIXTURES

- 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.
- B. 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, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.
- C. Proportion normal-weight concrete mixture as follows:
 - 1. Limit water-soluble, chloride-ion content in hardened concrete to 1.00 percent by weight of cement.
 - 2. 28-day Compressive Strength: 4000 psi minimum

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- 3. Entrained air 5-7%, at point of placement
- 4. Maximum-size aggregate: ³/₄ inch
- 5. Maximum water/cement ratio: 0.45
- 6. Minimum cement content: 611 lbs/cy (6.5 sack)
- D. Slump Limits: Proportion and design mixes to result in a concrete slump at point of placement of:
 - 1. Not less than 1" and not more than 4".
 - 2. When a high-range water-reducing admixture or a plasticizing admixture is approved, assure the concrete has a slump of 2" to 4" before the addition of the admixture, and a maximum slump of 8" at point of placement after admixture is added.

2.10 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.11 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.
 - 1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes or 250 revolutions of the mixing drum whichever occurs first.

PART 3 - EXECUTION

3.1 FORMWORK

- 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. Construct forms tight enough to prevent loss of concrete mortar.
- D. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces.
 - 1. Install keyways, reglets, recesses, and the like, for easy removal.

- 2. Do not use rust-stained steel form-facing material.
- E. 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.
- F. Chamfer exterior corners and edges of permanently exposed concrete per the Drawings.
- G. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
- H. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- I. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- J. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 EMBEDDED ITEMS

- 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's "Code of Standard Practice for Steel Buildings and Bridges."

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 deg F for 24 hours after placing concrete. 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 supports weight of concrete in place until concrete has achieved at least 70 percent of its 28-day design compressive strength and in the case of shored slabs no less than 14 days.
 - 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 will not be 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 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would 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.

3.5 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.
 - 2. Form keyed joints where indicated. Embed keys at least 1-1/2 inches into concrete.
 - 3. Locate horizontal joints in walls and columns at underside of floors, slabs, and beams, and at the top of footings or floor slabs.
 - 4. Space vertical joints in walls as indicated.
 - 5. 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 grooving 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 when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks. Cut joints no later than 18 hours after concrete has been placed.

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.

3.6 WATERSTOPS

- 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 fabricate joints in waterstops according to manufacturer's written instructions.
- B. All Waterstops: Maintain continuity of waterstops at all intersections and transitions.

3.7 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.
- B. 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.
- C. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be 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 to not exceed formwork design pressures and in a manner to avoid inclined construction joints. Lift heights shall not exceed 24 inches nor shall the fresh concrete be allowed to free fall more than 5 feet.
 - 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.
- D. 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.

CAST-IN-PLACE CONCRETE ISSUED FOR CONSTRUCTION

- 5. Begin initial floating using bull floats or darbies to form a uniform and opentextured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.
- E. Cold-Weather Placement: Comply with ACI 306.1.
- F. Hot-Weather Placement: Comply with ACI 305 and as follows:
 - 1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water.
 - 2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

3.8 ORDER OF PLACING CONCRETE

- A. General: The order of placing concrete shall be acceptable to the Engineer.
- B. In order to minimize the effects of shrinkage, the concrete shall be placed in units as bounded by the construction joints at the indicated locations on the Drawings.
- C. The placing of units shall be done by placing alternate units in a manner such that each unit placed shall have cured at least 5 days for hydraulic structures (basins and tanks) and 2 days for all other structures before the contiguous unit or units are placed, except that the corner sections of vertical walls shall not be placed until the 2 adjacent wall panels have cured at least 10 days for hydraulic structures and 4 days for all other structures.

3.9 FINISHING FORMED SURFACES

- A. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
 - 1. Apply to concrete surfaces exposed to view.
- B. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete where indicated:
 - 1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
- C. 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.
 - 1. Top of tanks and basin walls adjacent to walkways shall receive a porous trowel finish.

3.10 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. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.
 - 1. Apply float finish to surface of floor slab, surface of Thickener base and roof topping slab.
- C. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance.
 - 1. Apply a trowel finish to surface of floor slab, surface of Thickener base and roof topping slab.
 - 2. Finish and measure surface so gap at any point between concrete surface and an unleveled, freestanding, 10-ft-long straightedge resting on two high spots and placed anywhere on the surface does not exceed 1/4 inch.
- D. Broom Finish: Apply a broom finish to elevated concrete slabs of tanks and basins, and exterior concrete walks, steps, ramps, utility pads, and elsewhere as indicated.

3.11 MISCELLANEOUS CONCRETE ITEMS

- 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: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.

3.12 CONCRETE PROTECTING AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 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 the remainder of the curing period.
- D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs and other surfaces.
- E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
 - 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days.
 - 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moistureretaining 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.
 - 3. Curing Compound: 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.
 - 4. Curing and Sealing Compound: 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.

3.13 CONCRETE FLOOR SEALING

- A. Application of curing and sealing compound: Prepare, apply, and finish compound according to manufacturer's written instructions.
 - 1. Remove oil, dirt, laitance, and other contaminants and complete surface repairs.
 - 2. Apply compound at the recommended coverage rate until the surface is saturated and then apply a second at the prescribed rate in accordance with the manufacturer's written instructions.

3.14 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: Use non-shrink grout conforming to these specifications.
- 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 grout before bonding agent has dried. Fill form-tie voids with grout or cone plugs secured in place with epoxy bonding agent.

- 2. Repair defects on surfaces exposed to view using grout. Area beyond repaired defect shall be rubbed with a thin fluid layer of grout using burlap to match the surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact grout 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. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with fresh concrete. Finish repaired areas to blend into adjacent concrete.
 - 3. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
 - 4. 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 to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
 - 5. Repair random cracks and single holes 1 inch or less in diameter with grout. 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 grout before bonding agent has dried. Compact grout 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 grout.
- F. Repair materials and installation not specified above may be used, subject to Engineer's approval.

3.15 FIELD QUALITY CONTROL

A. Testing and Inspecting: Engineer will perform field tests and inspections and prepare test reports.

- B. Inspections:
 - 1. Steel reinforcement placement.
 - 2. Steel reinforcement welding.
 - 3. Headed bolts and studs.
 - 4. Verification of use of required design mixture.
 - 5. Concrete placement, including conveying and depositing.
 - 6. Curing procedures and maintenance of curing temperature.
 - 7. Verification of concrete strength before removal of shores and forms from beams and slabs.
- C. 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 will provide fewer than five compressivestrength 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/C 143M; 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/C 1064M; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
 - 5. Compression Test Specimens: ASTM C 31/C 31M.
 - a. Cast and laboratory cure one set of four standard cylinder specimens for each composite sample.
 - b. Cast and field cure one set of two standard cylinder specimens for each composite sample.
 - 6. Compressive-Strength Tests: ASTM C 39/C 39M; test one laboratory-cured specimen at 7 days and one set of two specimens at 28 days. The fourth cylinder shall be held in reserve in the event the 28 day tests fail to meet the specified compressive strength.
 - a. Test field-cured specimens as needed.
 - 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 28 days.
 - 7. When strength of field-cured cylinders is less than 85 percent of the 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/C 42M or by other methods as directed by the 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.

3.16 PROTECTION OF SEALED FLOOR

PART 4 - Protect sealed floor 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.

END OF SECTION 033000

SECTION 051200 - STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

- 1.1 SUMMARY
 - A. Section includes structural steel.

1.2 DEFINITIONS

A. Structural Steel: Elements of structural-steel frame, as classified by AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

1.3 PERFORMANCE REQUIREMENTS

A. Connections: Provide details of simple shear connections required by the Contract Documents to be selected or completed by structural-steel fabricator to withstand loads indicated and comply with other information and restrictions indicated.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show fabrication details and erection plan of structural steel components.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Welding certificates.
- C. Mill test reports for structural steel, including chemical and physical properties.
- D. Source quality-control reports.

1.6 QUALITY ASSURANCE

- A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD.
- B. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CSE.

- C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code Steel."
- D. Comply with applicable provisions of the following specifications and documents:
 - 1. AISC 303.
 - 2. AISC 360.
 - 3. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

PART 2 - PRODUCTS

- 2.1 STRUCTURAL-STEEL MATERIALS
 - A. W-Shapes & WT-Shapes: ASTM A 992/A 992M.
 - B. Channels, Angles: ASTM A 36/A 36M.
 - C. Plate and Bar: ASTM A 36/A 36M.
 - D. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade B, structural tubing.
 - E. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B.
 - F. Welding Electrodes: Comply with AWS requirements.

2.2 BOLTS, CONNECTORS, AND ANCHORS

- A. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade C, heavy-hex carbon-steel nuts; and ASTM F436, Type 1, hardened carbon-steel washers; all with plain finish.
- B. Headed Anchor Studs: ASTM A 108, Type A, headed-stud type, cold-finished carbon steel.
- C. Headed Anchor Rods: ASTM F 1554, Grade 55, straight.
 - 1. Finish: Galvanized.
- D. Threaded Rods: ASTM A 193 B7 or ASTM F 1554 Grade 55.
 - 1. Finish: Galvanized.

2.3 COATINGS

- A. Structural steel plates, shapes, bars and fabrications: Hot dip galvanize in accordance with ASTM A123.
- B. Structural steel hardware: Hot dip galvanize in accordance with ASTM A153 or mechanically deposited zinc coatings per ASTM B695.

STRUCTURAL STEEL FRAMING ISSUED FOR CONSTRUCTION C. Fasteners: Hot dip galvanize in accordance with ASTM 2329 or plating per ASTM F1941.

2.4 GROUT

- A. Metallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, metallic aggregate grout, mixed with water to consistency suitable for application and a 30-minute working time.
- B. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.5 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC 360.
- B. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

2.6 SHOP CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
 - 1. Joint Type: Snug tightened.
- B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

2.7 SOURCE QUALITY CONTROL

- A. Testing Agency: Owner will engage an independent testing and inspecting agency to perform shop tests and inspections and prepare test reports.
 - 1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.
- B. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.
- C. Bolted Connections: Shop-bolted connections will be inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

- D. Welded Connections: In addition to visual inspection, shop-welded connections will be tested and inspected according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
 - 1. Liquid Penetrant Inspection: ASTM E 165.
 - 2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
 - 3. Ultrasonic Inspection: ASTM E 164.
 - 4. Radiographic Inspection: ASTM E 94.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify, with steel Erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.
- B. Base Bearing and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.
 - 1. Set plates for structural members on wedges, shims, or setting nuts as required.
 - 2. Weld plate washers to top of baseplate.
 - 3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
 - 4. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure.
- C. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."

3.3 FIELD CONNECTIONS

- A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
 - 1. Joint Type: Snug tightened.

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- B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
 - 1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engineer will inspect field welds and high-strength bolted connections.
- B. Bolted Connections: Bolted connections will be inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- C. Welded Connections: Field welds will be visually inspected according to AWS D1.1/D1.1M.
 - 1. In addition to visual inspection, field welds will be tested and inspected according to AWS D1.1/D1.1M and the following inspection procedures, at the Engineer's option:
 - a. Liquid Penetrant Inspection: ASTM E 165.
 - b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
 - c. Ultrasonic Inspection: ASTM E 164.
 - d. Radiographic Inspection: ASTM E 94.
- D. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents at no additional cost to the Owner.

END OF SECTION 051200

SECTION 055000 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Miscellaneous steel framing and supports.
 - 2. Steel Weld Plates and Angles
- B. Products furnished, but not installed, under this Section include the following:
 - 1. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
 - 2. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.

1.2 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Grout.
 - 2. Coatings.
- B. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections.
- C. Delegated-Design Submittal: For ladders, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014500 "Quality Control," to design ladders.
- B. 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 deg F, ambient.

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/A 36M.
- C. Stainless-Steel Bars and Shapes: ASTM A 276, Type 304.
- D. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.
- E. Rolled-Stainless-Steel Floor Plate: ASTM A 793.
- F. Steel Tubing: ASTM A 500/A 500M, cold-formed steel tubing.
- G. Steel Pipe: ASTM A 53/A 53M, Standard Weight (Schedule 40) unless otherwise indicated.
- H. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.
 - 1. Size of Channels: 1-5/8 by 1-5/8 inches.
 - 2. Material: Galvanized steel, ASTM A 653/A 653M, structural steel, Grade 33 with G90 coating; 0.108-inch nominal thickness.
- I. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.

2.3 FASTENERS

- A. General: Unless otherwise indicated, provide high strength bolts conforming to ASTM A 325 or carbon steel bolts conforming to ASTM A 307 as indicated on the drawings. Hex nuts and washers are to comply with ASTM B563 and F436 respectively. All bolts, washers and nuts are to be hot dip galvanized per ASTM F2329 or electrodeposited zinc plating per ASTM F1941.
- B. Cast-in-Place Anchors in Concrete: Cast in anchor rods to conform to ASTM F1554 Grade 55 and are to be galvanized or coated per part A above.
- C. Post-Installed Anchors: Torque-controlled expansion anchors or adhesive anchors.
 - 1. Torque-controlled expansion anchors: per the manufacturer and are to be coated per this specification.
 - 2. Adhesive anchors: Rod material is to conform to ASTM A193 B7 and are to be coated per this specification.
- D. 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. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- B. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- C. Concrete: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained, concrete with a minimum 28-day compressive strength of 4000 psi.

2.5 FABRICATION, GENERAL

- A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Use connections that maintain structural value of joined pieces.
- B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges. Remove sharp or rough areas on exposed surfaces.
- C. 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.
- D. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Locate joints where least conspicuous.
- E. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- F. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors not less than 8 inches from ends and corners of units and 24 inches o.c unless noted otherwise.

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.
- C. Fabricate steel girders for wood frame construction from continuous steel shapes of sizes indicated.
 - 1. Where wood nailers are attached to girders with bolts or lag screws, drill or punch holes at no more than 24 inches o.c.
- D. 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.

2.7 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.
- 2.8 FINISHES, GENERAL
 - A. Finish metal fabrications after assembly.

2.9 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products. Mechanically deposited zinc coatings conforming to ASTM B695 are also acceptable.

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.
- E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

3.2 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.
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780/A 780M.

END OF SECTION 055000

SECTION 055100 - METAL STAIRS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Industrial-type stairs with steel grating treads.

1.2 ACTION SUBMITTALS

- A. Product Data: For metal stairs.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1.3 QUALITY ASSURANCE

- A. NAAMM Stair Standard: Comply with "Recommended Voluntary Minimum Standards for Fixed Metal Stairs" in NAAMM AMP 510, "Metal Stairs Manual," for class of stair designated, unless more stringent requirements are indicated.
 - 1. Industrial-Type Stairs: Industrial class.

PART 2 - PRODUCTS

2.1 METALS

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
- B. Steel Plates, Shapes, and Bars: ASTM A 36.
- C. Steel Bars for Grating Treads: ASTM A 1011 or ASTM A 1018.
- D. Wire Rod for Grating Crossbars: ASTM A 510.

2.2 FASTENERS

A. General: Provide zinc-plated fasteners with coating complying with ASTM B 633. Select fasteners for type, grade, and class required.

B. Bolts and Nuts: For bolt diameters of 1/2" or less, regular hexagon-head bolts, ASTM A307, Grade A; with hex nuts, ASTM A 563; and where indicated, flat washers.

2.3 FABRICATION, GENERAL

- A. Provide stair assemblies, including metal framing, hangers, struts, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.
 - 1. Join components by shop welding and field bolting, except where indicated.
 - 2. Use connections that maintain structural value of joined pieces.
 - 3. Coordinate railing attachment with railing manufacturer.
- B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges. Remove sharp or rough areas on exposed surfaces.
- C. Weld connections 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. Weld exposed corners and seams continuously unless otherwise indicated.

2.4 STEEL-FRAMED STAIRS

- A. Stair Framing:
 - 1. Fabricate stringers of steel channels.
 - 2. If using bolts, fabricate and join so bolts are not exposed on finished surfaces.
- B. Metal Bar-Grating Stairs: Comply with NAAMM MBG 531, "Metal Bar Grating Manual."
 - 1. Fabricate treads and platforms from steel grating with 1-by-3/16-inch bearing bars at 1 3/16 inch o.c and crossbars at 4 inches o.c.
 - 2. Fabricate grating treads with slip resistant nosing and with steel angle or steel plate carrier at each end for stringer connections. Secure treads to stringers with bolts.

2.5 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. 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.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.
- B. Install metal stairs by bolting as indicated.
- C. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication.

3.2 ADJUSTING AND CLEANING

A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 055100

SECTION 055213 - PIPE AND TUBE RAILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:1. Aluminum pipe and tube railings.
- B. Related Sections:
 1. Section 055100 "Metal Stairs" for steel tube railings associated with metal stairs.

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design railings and their anchorage to supporting members, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated to conform to OSHA requirements.
- B. General: In engineering railings to withstand structural loads indicated, determine allowable design working stresses of railing materials based on the following:
 - 1. Aluminum: The lesser of minimum yield strength divided by 1.65 or minimum ultimate tensile strength divided by 1.95.
- C. Structural Performance: Railings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 - 1. Handrails and Top Rails of Guards:
 - a. Uniform load of 20 lbf/ ft.applied in any direction.
 - b. Concentrated load of 200 lbf applied in any direction.
 - c. Uniform and concentrated loads need not be assumed to act concurrently.
 - 2. Infill of Guards:
 - a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft.
 - b. Infill load and other loads need not be assumed to act concurrently.
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling,

PIPE AND TUBE RAILINGS ISSUED FOR CONSTRUCTION opening of joints, overstressing of components, failure of connections, and other detrimental effects.

Differential values in subparagraph below (for aluminum in particular) are suitable for most of the U.S.

- 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.
- E. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Manufacturer's product lines of mechanically connected railings.
 - 2. Railing brackets.
 - 3. Grout and anchoring cement.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
- C. Samples for Verification: For each type of exposed finish required.
 - 1. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters.
 - 2. Fittings and brackets.
 - 3. Assembled Sample of railing system, made from full-size components, including railings, posts, bases, toe plates, and fittings. Sample need not be full height.
 - a. Show method of connecting members at intersections.
- D. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, according to ASTM E 894 and ASTM E 935.

1.6 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of railing from single source from single manufacturer.
- B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

1.8 COORDINATION AND SCHEDULING

- A. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- B. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not satisfy structural performance requirements.

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. Aluminum Pipe and Tube Railings:
 - a. ATR Technologies, Inc.
 - b. Peak to Peak Engineered Railings
 - c. Blum, Julius & Co., Inc.
 - d. Braun, J. G., Company; a division of the Wagner Companies.
 - e. CraneVeyor Corp.
 - f. Hollaender Manufacturing Company.
 - g. Kee Industrial Products, Inc.
 - h. Pisor Industries, Inc.
 - i. Sterling Dula Architectural Products, Inc.; Div. of Kane Manufacturing.
 - j. Superior Aluminum Products, Inc.
 - k. Thompson Fabricating, LLC.
 - I. Tri Tech, Inc.
 - m. Tubular Specialties Manufacturing, Inc.
 - n. Tuttle Railing Systems; Div. of Tuttle Aluminum & Bronze, Inc.
 - o. Wagner, R & B, Inc.; a division of the Wagner Companies.

2.2 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

PIPE AND TUBE RAILINGS ISSUED FOR CONSTRUCTION B. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.

2.3 ALUMINUM

- A. Aluminum, General: Provide alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of alloy and temper designated below for each aluminum form required.
 - 1. Railings and posts to be 1 1/2" nominal pipe or round tubing.
- B. Extruded Bars and Tubing, such as railings: ASTM B 221, Alloy 6063-T6.
- C. Extruded Structural Pipe and Tubing, such as posts: ASTM B 429, Alloy 6061-T6 or 6105-T5.
- D. Plate and Sheet: ASTM B 209, Alloy 6061-T6.
- E. Die and Hand Forgings: ASTM B 247, Alloy 6061-T6.
- F. Castings: ASTM B 26, Alloy A356.0-T6 or same as prime extrusions.

2.4 FASTENERS

- A. General: Provide the following:
 - 1. Aluminum Railings: Type 304 stainless-steel fasteners.
- B. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads.
 - 1. Furnished by the handrail manufacturer.
- C. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.
 - 1. Stainless steel type 303 or 304 anchors furnished by the handrail manufacturer.

2.5 MISCELLANEOUS MATERIALS

A. 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.

2.6 FABRICATION

- A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.
- B. Assemble railings in the shop to greatest extent possible to minimize field splicing and assembly, but not to exceed lengths of 25 feet for field installation. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.
- C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inchunless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- D. Form work true to line and level with accurate angles and surfaces.
- E. Space posts a maximum of 5'-0" o.c. for stair railings and 6'-0" o.c. elsewhere.
- F. Provide intermediate railings such that a 21 inch diameter sphere cannot pass through any opening.
- G. Posts shall not interrupt the continuation of the top rail at any point along the railing, including corners and end terminations. The top surface of the top railing is to be smooth and not interrupted by projected fittings.
- H. Connections: Fabricate railings with nonwelded connections.
 - 1. Connect members with concealed mechanical fasteners and component fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.
 - 2. Pop-riveted or glued joints shall not be used.
- I. Form changes in direction as follows:
 - 1. By bending or by inserting prefabricated elbow fittings.
- J. Bend members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
- K. Close exposed ends of railing members with prefabricated end fittings.
- L. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.
- M. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.

- N. For railing posts set in concrete, provide steel sleeves not less than 6 inches long with inside dimensions not less than 1/2 inch greater than outside dimensions of post, with metal plate forming bottom closure.
- O. For removable railing posts, fabricate slip-fit sockets from steel tube or pipe whose ID is sized for a close fit with posts; limit movement of post without lateral load, measured at top, to not more than one-fortieth of post height. Provide socket covers designed and fabricated to resist being dislodged.
- P. Toe Boards: Where indicated, provide toe boards at railings around openings and at edge of open-sided floors and platforms.
 - 1. Provide toe board for all railings connected to concrete members or surfaces.
 - 2. Conform to OSHA standards. Provide toe board with minimum height of 4 inches that attaches to the posts with clamps or bolting.
 - 3. Place bottom of toe board 1/4" above walking surface.
- 2.7 FINISHES, GENERAL
 - A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
 - C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
 - D. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.

2.8 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I or thicker.

PART 3 - EXECUTION

- 3.1 INSTALLATION, GENERAL
 - A. Fit exposed connections together to form tight, hairline joints.
 - B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

- 1. Do not weld, cut, or abrade surfaces of railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical fastening.
- 2. Set posts plumb within a tolerance of 1/16 inch in 4 feet.
- 3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.
- C. Corrosion Protection: Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, or dissimilar metals, with a heavy coat of bituminous paint, mylar isolators or other approved material.
- D. Adjust railings before anchoring to ensure matching alignment at abutting joints.
- E. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.2 RAILING CONNECTIONS

- A. Nonwelded Connections: Use mechanical joints for permanently connecting railing components. Seal recessed holes of exposed locking screws.
- B. Expansion Joints: Install expansion joints not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 2 inchesbeyond joint on either side, fasten internal sleeve securely to one side, and locate joint within 6 inchesof post.

3.3 ANCHORING POSTS

A. Anchor posts per manufacturer's recommendations using mechanically connected bases engineered or tested for this purpose.

3.4 ADJUSTING AND CLEANING

A. Clean aluminum by washing thoroughly with clean water and soap and rinsing with clean water.

3.5 PROTECTION

A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

END OF SECTION 055213

SECTION 055300 - METAL GRATINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Metal bar gratings.
- B. Related Sections:
 - 1. Section 051200 "Structural Steel Framing" for structural-steel framing system components.
 - 2. Section 055100 "Metal Stairs" for grating treads and landings of steel-framed stairs.
 - 3. Section 055213 "Pipe and Tube Railings" for metal pipe and tube handrails and railings.

1.3 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. Walkways and Elevated Platforms: Uniform load of 60 lbf/sq. ft.
 - 2. Limit deflection to L/240 or 1/4 inch, whichever is less.

1.4 ACTION SUBMITTALS

A. Shop Drawings: Include plans, sections, details, and attachments to other work.

1.5 QUALITY ASSURANCE

- A. Metal Bar Grating Standards: Comply with NAAMM MBG 531, "Metal Bar Grating Manual."
- B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code Steel."

1.6 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with gratings by field measurements before fabrication.

1.7 COORDINATION

A. Coordinate installation of anchorages for gratings, grating frames, and supports. Furnish setting drawings, templates, and directions for installing anchorages.

PART 2 - PRODUCTS

- 2.1 FERROUS METALS
 - A. Steel Bars for Bar Gratings: ASTM A 1011 or ASTM A 1018.
 - B. Wire Rod for Bar Grating Crossbars: ASTM A 510.

2.2 FASTENERS

- A. General: Provide zinc-plated fasteners with coating complying with ASTM B 633. Select fasteners for type, grade, and class required.
 - 1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.
- 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.

2.3 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy that is welded.
- B. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20.

2.4 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. Form from materials of size, thickness, and shapes indicated, but not less than that needed to support indicated loads.
- D. Fit exposed connections accurately together to form hairline joints.
- E. 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.
- F. 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.
- G. Provide bands at all cutouts and where bearing bars are interrupted. Weld banding to each cut bearing bar.
- H. Where grating forms the landing at the top of a stairway, provide a slip resistant nosing at the leading edge of the landing. Match the nosing provided on the stair treads in type and length.

2.5 METAL BAR GRATINGS

- A. Welded Steel Grating:
 - 1. Bearing Bar Spacing: 1-3/16 inches o.c.
 - 2. Bearing Bar Depth: 1-1/2 inches.
 - 3. Bearing Bar Thickness: 1/8 inch, minimum.
 - 4. Crossbar Spacing: 4 inches o.c.
 - 5. Traffic Surface: Plain.
 - 6. Steel Finish: Hot-dip galvanized with a coating weight of not less than 1.8 oz./sq. ft. of coated surface.

2.6 GRATING FRAMES AND SUPPORTS

- A. Frames and Supports for Metal Gratings: 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.
- B. Galvanize steel frames and supports.

2.7 STEEL FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish gratings, frames, and supports after assembly.
- C. 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.

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. 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.

3.2 INSTALLING METAL BAR GRATINGS

- A. General: Install gratings to comply with recommendations of referenced metal bar grating standards that apply to grating types and bar sizes indicated, including installation clearances and standard anchoring details.
- B. Attach removable units to supporting members with type and size of clips and fasteners indicated or, if not indicated, as recommended by grating manufacturer for type of installation conditions shown.
- C. Attach nonremovable units to supporting members by welding where both materials are same; otherwise, fasten by bolting as indicated above.

3.3 ADJUSTING AND CLEANING

A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 055300

METAL GRATINGS ISSUED FOR CONSTRUCTION PAGE 055300 - 5 MARCH 2018

SECTION 260500 - ELECTRICAL WORK, GENERAL

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall provide electrical work, complete and operable, in accordance with the Contract Documents.
- B. The provisions of this Section apply to all sections in Division 26, except as indicated otherwise.
- C. The WORK of this Section is required for operation of electrically-driven equipment provided under specifications in other Divisions. The CONTRACTOR's attention is directed to the requirement for proper coordination of the WORK of this Section with the WORK of equipment specifications, and the WORK of instrumentation sections.
- D. Concrete, excavation, backfill, and steel reinforcement required for encasement, installation, or construction of the WORK of the various sections of Division 26 is included as a part of the WORK under the respective sections, including duct banks, manholes, handholes, equipment housekeeping pads, and light pole bases.
- E. The CONTRACTOR shall coordinate with the serving utility, Alaska Power and Telephone (AP&T), as necessary for all work to be done in modification of the existing electrical service. All required utility fees shall be paid for by the CONTRACTOR.

1.2 REFERENCE STANDARDS

- A. The WORK of this Section and all sections in Division 26 shall comply with the following, as applicable:
 - NEC (NFPA 70) National Electrical Code
 - NETA International Electrical Testing Association
 - NEMA 250 Enclosure for Electrical Equipment (1000 Volts Maximum)
- B. Electrical equipment shall be listed by and shall bear the label of Underwriters' Laboratories, Inc. (UL) or other State of Alaska recognized testing laboratory.
- C. Installation of electrical equipment and materials shall comply with OSHA Safety and Health Standards, state building standards, and applicable local codes and regulations.
- D. Where the requirements of the specifications conflict with UL, NEMA, NFPA, or other applicable standards, the more stringent requirements shall govern.
1.3 SIGNAGE

- A. Local Disconnect Switches:
- 1 Each local disconnect switch for motors and equipment shall be legibly marked to indicate its purpose, unless the purpose is indicated by the location and arrangement.
- B. Warning Signs:
- 1 600 volts nominal, or less. Entrances to rooms and other guarded locations that contain live parts shall be marked with conspicuous signs prohibiting entry by unqualified persons.
- C. Isolating Switches: Isolating switches not interlocked with an approved circuit interrupting device shall be provided with a sign warning against opening them under load.
- 1.4 PUBLIC UTILITIES REQUIREMENTS
 - A. The Public Electrical Utility associated with this project is Alaska Power & Telephone (AP&T). The CONTRACTOR shall coordinate all requirements with the Utility.
 - B. The CONTRACTOR shall contact the serving utility and verify compliance with requirements before construction. The CONTRACTOR shall coordinate schedules and payments for work by all utilities.
 - C. Electrical service shall be as indicated and be as required by the serving utility.
 - D. The CONTRACTOR shall verify and provide all service conduits, fittings, grounding devices, and all service wires not provided by the serving utility.
 - E. The CONTRACTOR shall verify with the utility the exact location of each service point and type of service, and shall pay all charges levied by the serving utilities as part of the WORK.
- 1.5 PERMITS AND INSPECTION
 - A. All electrical permits shall be obtained and inspection fees shall be paid by the CONTRACTOR.
 - B. The CONTRACTOR shall pay all line extension, service upgrade, equipment, connection and turn-on service charges required by the utility company.
- 1.6 CONTRACTOR SUBMITTALS
 - A. Furnish submittals in accordance with Section 01 33 00 Submittal Procedure.
 - B. Shop Drawings: Include the following:

- 1 Complete material lists stating manufacturer and brand name of each item or class of material.
- 2 Shop Drawings for all grounding WORK not specifically indicated.
- 3 Front, side, rear elevations, and top views with dimensional data.
- 4 Location of conduit entrances and access plates.
- 5 Component data.
- 6 Connection diagrams, terminal numbers, internal wiring diagrams, conductor size, and cable numbers.
- 7 Method of anchoring, seismic requirements, weight.
- 8 Types of materials and finish.
- 9 Nameplates.
- 10 Temperature limitations, as applicable.
- 11 Voltage requirement, phase, and current, as applicable.
- 12 Front and rear access requirements.
- 13 Test reports.
- 14 Grounding requirements.
- 15 Catalog cuts of applicable pages of bulletins or brochures for mass produced, noncustom manufactured material. Catalog data sheets shall be stamped to indicate the project name, applicable Section and paragraph; and shall be clearly marked to indicate exact model number, and options being provided.
- C. Shop Drawings shall be custom prepared. Drawings or data indicating "optional" or "as required" equipment are not acceptable. Options not proposed shall be crossed out or deleted from Shop Drawings.
- D. Materials and Equipment Schedules: The CONTRACTOR shall deliver to the ENGINEER within 30 days of the commencement date in the Notice to Proceed, a complete list of all materials, equipment, apparatus, and fixtures proposed for use. The list shall include type, sizes, names of manufacturers, catalog numbers, and other such information required to identify the items.
- E. Owner's Manuals: Complete information in accordance with Section 01 33 00.

- F. Record Drawings: The CONTRACTOR shall show invert and top elevations and routing of all duct banks and concealed below-grade electrical installations. Record Drawings shall be prepared, be available to the ENGINEER, and be submitted according to Section 01 33 00.
- 1.7 AREA DESIGNATIONS
 - A. General:
 - 1 Raceway system enclosures shall comply with Section 26 05 33 Raceway and Boxes for Electrical Systems.
 - 2 Electrical WORK specifically indicated in sections within any of the Specifications shall comply with those requirements.
 - 3 Electrical WORK in above ground indoor non-process areas shall be NEMA 1.
 - 4 Electrical WORK in damp or wet locations and process areas shall be NEMA 4X unless otherwise indicated.
 - 5 Electrical WORK in below ground facilities and outdoors shall be NEMA 4X unless otherwise indicated.
 - 6 Installations in hazardous locations shall conform strictly to the requirements of the Class, Group, and Division indicated.
 - B. Material Requirements:
 - 1 NEMA 4X enclosures shall be stainless steel, Type 304 or 316.
- 1.8 TESTS
 - A. The CONTRACTOR shall be responsible for factory and field tests required by specifications in Division 26 and by the ENGINEER or authority having jurisdiction. The CONTRACTOR shall furnish necessary testing equipment and pay costs of tests, including all replacement parts and labor, due to damage resulting from damaged equipment or from testing and correction of faulty installation.
 - B. Where test reports are indicated, proof of design test reports for mass-produced equipment shall be submitted with the Shop Drawings, and factory performance test reports for custom-manufactured equipment shall be submitted and be approved prior to shipment. Field test reports shall be submitted for review prior to Substantial Completion.
 - C. Equipment or material which fails a test shall be removed and replaced.
 - Cable Testing: Cables and conductors shall be tested in accordance with Section 26 05 19.

- E. Test Ground Fault Interrupter (GFI) receptacles and circuit breakers for proper operation by methods sanctioned by the receptacle manufacturer.
- F. A functional test and check of all electrical components is required prior to performing subsystem testing and commissioning. Compartments and equipment shall be cleaned as required by other provisions of these Specifications before commencement of functional testing. Functional testing shall comprise:
 - 1 Visual and physical check of cables, circuit breakers, transformers and connections associated with each item of new and modified equipment.
 - 2 Circuit breakers that have adjustable time or pick-up settings for ground current, instantaneous overcurrent, short-time overcurrent, or long-time overcurrent, shall be field-adjusted by a representative of the circuit breaker manufacturer. Setting shall be tabulated and proven for each circuit breaker in its installed position. Test results shall be certified by the person performing the tests and be transmitted to the ENGINEER.
- G. Complete ground testing of grounding electrodes per requirements prior to operating the equipment.
- H. Subsystem testing shall occur after the proper operation of alarm and status contacts has been demonstrated or otherwise accepted by the ENGINEER and after process control devices have been adjusted as accurately as possible. It is intended that the CONTRACTOR will adjust limit switches and level switches to their operating points prior to testing and will set pressure switches, flow switches, and timing relays as dictated by operating results.
- After initial settings have been completed, each subsystem shall be operated in the manual mode and it shall be demonstrated that operation is in compliance with the Contract Documents. Once the manual mode of operation has been proven, automatic operation shall be demonstrated to verify such items as proper start and stop sequence of pumps, proper operation of valves, proper speed control, etc.
- 1.9 DEMOLITION AND RELATED WORK
 - A. The CONTRACTOR shall perform electrical demolition WORK as indicated on the electrical drawings and in parts of this Specification Section. The CONTRACTOR is cautioned that demolition WORK may also be indicated on non-electrical drawings. Coordinate electrical de-energization, disconnection, and removal with all trades and the overall sequence of construction.
 - B. Electrical requirements associated with removed equipment shall be:
 - 1 Remove power, control and signal wiring as indicated.
 - 2 Remove all abandoned exposed raceways.
 - 3 Encased conduits shall be cut flush to the floor and be grouted.

- 4 Remove remote mounted starters, disconnect switches, circuit breakers, sensors, and transmitters
- 5 Remove panels, switchboards, transfer switch, etc.
- 6 Remove remote mounted status lights and switches where indicated on the electrical drawings, and blank off openings in existing panels with field-fabricated stainless steel plates. Plates shall be attached with stainless steel finish screws.
- 7 Remove control panels, concrete bases and posts for panels.
- 8 Remove pump cords, level sensors, level switches.
- C. Where new lighting and receptacles are installed, old lighting, receptacles, switches, wiring, and conduits shall be removed.
- D. Raceways to be reused or extended shall be terminated in a new junction box. The junction box shall have a NEMA rating in accordance with the area in which it is located and shall be sized as required.
- E. Materials and equipment not indicated to be removed and returned to the OWNER shall, upon removal, become the CONTRACTOR's property and shall be disposed of off-site.
- F. Material and equipment indicated to be relocated or reused shall be removed and relocated, and reinstalled with care to prevent damage thereto.
- G. Materials indicated to be returned to the OWNER shall be placed in boxes with the contents clearly marked and be stored at a location determined by the ENGINEER.
- H. Where MCCs or panelboards are indicated to have circuits removed and reconnected, the MCC shall have a new engraved phenolic nameplate worded as indicated, and the panelboard schedule shall be modified to indicate the revised circuits. Pencil or magic marker markings directly on the MCC or panelboard breaker are not permitted.
- 1.10 CONSTRUCTION SEQUENCING
 - A. Continuance of facility operation during demolition and construction is critical at this facility. Therefore, the CONTRACTOR shall carefully examine all work to be done in, on, or adjacent to existing equipment. Work shall be scheduled, subject to the OWNER's approval, to minimize required process or equipment shutdown time. The CONTRACTOR shall submit a written request including sequence and duration of activities to be performed during plant shutdown.
 - B. Temporary power and communications between existing facilities may be required. Temporary systems shall be in place and staged for switchover prior to disconnection of any active circuits.

- C. All switching, safety tagging, etc., required for process or equipment shutdown or to isolate existing equipment shall be performed by the CONTRACTOR. In no case shall the CONTRACTOR begin any work in, on, or adjacent to existing equipment without written authorization by the plant supervisor and the ENGINEER. The CONTRACTOR shall remove the lock within 4 hours upon request of the OWNER, in an emergency, and if the equipment is operable.
- D. The CONTRACTOR shall make all modifications or alterations to existing electrical facilities required to successfully install and integrate the new electrical equipment as indicated on the electrical drawings. Modifications to existing equipment, panels, or cabinets shall be made in a professional manner with all coatings repaired to match existing. The CONTRACTOR is responsible for ensuring all panels and equipment are UL-listed. The costs for modifications (including UL listing) to existing electrical facilities required for a complete and operating system shall be included in the CONTRACTOR's original Bid amount and no additional payment for this WORK will be authorized.
- E. Extreme caution shall be exercised by the CONTRACTOR in digging trenches in order not to damage existing underground utilities. Cost of repairs of damages caused during construction shall be the CONTRACTOR's responsibility without any additional compensation from the OWNER.
- F. The CONTRACTOR shall be responsible for identifying available existing circuit breakers in lighting panels for the intended use as required by the Drawings. The CONTRACTOR shall also be responsible for field-verifying the available space in panelboards to integrate new circuit breakers. Costs for this WORK shall be included in the CONTRACTOR's original Bid amount.
- G. The CONTRACTOR is advised to visit the Site before submitting a Bid to better acquaint itself with the WORK of this Contract. Lack of knowledge will not be accepted as a reason for granting extra compensation to perform the WORK.
- H. 1.11 INSTALLATION OF NEW EQUIPMENT:
- 1 The CONTRACTOR will install and terminate the new switchboards, motor starters, control panels, wireways, cables, and instruments, etc. in accordance with the agreed schedule. The CONTRACTOR shall provide a list, daily, of the points that are ready for service as they are connected, calibrated, and tested. The CONTRACTOR shall only connect to equipment that is new or is out of service.
- 2 The recommended construction sequence is as follows:
 - a. Provide temporary power and communication provisions.
 - b. Remove all demolition items and make good all surfaces before applying appropriate surface finish and paint.

- c. Install new switchboards, motor starters, control panels and instruments.
- d. Install new raceways between switchboards, motor starters, instruments, and new control panel.
- e. Install all new wiring as specified.
- f. Complete wiring modifications to existing equipment.
- 3 Allowable down time requirements: The CONTRACTOR shall minimize the amount of time a facility is out of service. All outages shall be scheduled with the OWNER and ENGINEER a minimum of two (2) days prior to outage. Scheduled outages shall last no longer than two (2) hours.
- 4 The OWNER shall take beneficial occupancy of each facility as the WORK is signed off.

PART 2 -- PRODUCTS

- 2.1 GENERAL
 - A. Equipment and materials shall be new, shall be listed by UL, and shall bear the UL label where UL requirements apply. Equipment and materials shall be the products of experienced and reputable manufacturers in the industry. Similar items in the WORK shall be products of the same manufacturer. Equipment and materials shall be of industrial grade standard of construction.
 - B. Where a NEMA enclosure type is indicated in a non-hazardous location, the CONTRACTOR shall utilize that type of enclosure, despite the fact that certain modifications, such as cutouts for control devices, may negate the NEMA rating.
 - C. On devices indicated to display dates, the year shall be displayed as 4 digits.

2.2 MOUNTING HARDWARE

- A. Miscellaneous Hardware:
 - 1 Nuts, bolts, and washers shall be stainless steel when used with PVC-Coated raceway and boxes or stainless steel enclosures. Hot-dipped galvanized nuts, bolts and washers may be used with galvanized rigid conduit (GRC) and enclosures that are not constructed of stainless steel.
 - 2 Threaded rods for trapeze supports shall be continuous-threaded, stainless steel, 3/8inch diameter minimum, when used with PVC-coated raceway and boxes. Hot-dipped galvanized hardware may be used with GRC.

- 3 Strut for mounting of raceways and equipment shall be galvanized or stainless steel as required by the area classification. Where contact with concrete or dissimilar metals may cause galvanic corrosion, suitable non-metallic insulators shall be utilized to prevent such corrosion. Strut shall be as manufactured by **Unistrut, B-Line,** or equal.
- 4 Anchors for attaching equipment to concrete walls, floors and ceilings shall be stainless steel expansion anchors, such as "Rawl-Bolt," "Rawl-Stud" or "Lok-Bolt" as manufactured by Rawl; similar by Star, or equal. Wood plugs shall not be used.

2.3 ELECTRICAL IDENTIFICATION

- A. Nameplates: Nameplates shall be fabricated from white-letter, black-face laminated plastic engraving stock, Formica type ES-1, or equal. Each shall be fastened securely, using fasteners of brass, cadmium-plated steel, or stainless steel, screwed into inserts or tapped holes, as required. Engraved characters shall be block style, with no characters smaller than 1/8-inch in height.
- B. Conductor and Equipment Identification: Conductor and equipment identification devices shall be heat-shrink plastic tubing with machine printing. Lettering shall read from left to right and shall face toward the front of the panel.

PART 3 -- EXECUTION

- 3.1 GENERAL
 - A. Incidentals: The CONTRACTOR shall provide all materials and incidentals required for a complete and operable system, even if not required explicitly by the Specifications or the Drawings. Typical incidentals are terminal lugs not furnished with vendor-supplied equipment, compression connectors for cables, splices, junction and terminal boxes, and control wiring required by vendor-furnished equipment to connect with other equipment indicated in the Contract Documents.
 - B. Field Control of Location and Arrangement: The Drawings diagrammatically indicate the desired location and arrangement of outlets, conduit runs, equipment, and other items. Exact locations shall be determined by the CONTRACTOR in the field, based on the physical size and arrangement of equipment, finished elevations, and other obstructions. Locations on the Drawings, however, shall be followed as closely as possible.
 - 1 Where raceway development drawings, or "home runs," are shown, the CONTRACTOR shall route the raceways in accordance with the indicated installation requirements.
 - 2 Conduit and equipment shall be installed in such a manner as to avoid all obstructions and to preserve headroom and keep openings and passageways clear. Lighting fixtures, switches, convenience outlets, and similar items shall be located within finished rooms as indicated. Where the Drawings do not indicate exact locations, the ENGINEER shall determine such locations. If equipment is installed without instruction and must be moved, it shall be moved without additional cost to the OWNER. Lighting

fixture locations shall be adjusted slightly to avoid obstructions and to minimize shadows.

- 3 Wherever raceways and wiring for lighting and receptacles are not indicated, it shall be the CONTRACTOR's responsibility to provide all lighting and receptacle-related conduits and wiring as required, based on the actual installed fixture layout and the circuit designations as indicated. Wiring shall be #12 AWG minimum, and conduits shall be 3/4-inch minimum. Where circuits are combined in the same raceway, the CONTRACTOR shall de-rate conductor ampacities in accordance with NEC requirements.
- C. Workmanship: Materials and equipment shall be installed in strict accordance with printed recommendations of the manufacturer. Installation shall be accomplished by workers skilled in the work. Installation shall be coordinated in the field with other trades to avoid interferences.
- D. Protection of Equipment and Materials: The CONTRACTOR shall fully protect materials and equipment against damage from any cause. Materials and equipment, both in storage and during construction, shall be covered in such a manner that no finished surfaces will be damaged, marred, or splattered with water, foam, plaster, or paint. Moving parts shall be kept clean and dry. The CONTRACTOR shall replace or refinish damaged materials or equipment, including faceplates of panels and switchboard sections, as part of the WORK.
- E. Incoming utility power equipment shall be provided in conformance with the utility's requirements.

3.2 CORE DRILLING

- A. The CONTRACTOR shall perform core drilling required for installation of raceways through concrete walls, floors and handholes. Locations of floor penetrations, as may be required, shall be based on field conditions. Verify all exact core drilling locations based on equipment actually furnished, as well as exact field placement. To the extent possible, identify the existence and locations of encased raceways and other piping in existing walls and floors with the OWNER prior to any core drilling activities. Damage to any encased conduits, wiring, and piping shall be repaired as part of the WORK.
- B. All penetrations required to extend raceways through concrete walls, roofs, and floors or masonry walls shall be core drilled.

3.3 EQUIPMENT ANCHORING

A. Floor supported, wall-, or ceiling-hung equipment and conductors shall be anchored in place by methods that will meet seismic requirements in the area where the project is located. Wall-mounted panels that weigh more than 500 pounds, or which are within 18 inches of the floor, shall be provided with fabricated steel (stainless steel in designated areas) support pedestals. If the supported equipment is a panel or cabinet enclosed

within removable side plates, it shall match supported equipment in physical appearance and dimensions. Transformers hung from 4-inch stud walls and weighing more than 300 pounds shall have auxiliary floor supports.

- B. Anchoring methods and leveling criteria in the printed recommendations of the equipment manufacturers are a part of the WORK of this Contract. Such recommendations shall be submitted as Shop Drawings under Section 01 33 00.
- C. Panels, raceways, and other equipment shall be anchored and supported for Seismic requirements.
- 3.4 EQUIPMENT IDENTIFICATION
 - A. General: Equipment and devices shall be identified as follows:
 - 1 Nameplates shall be provided for all switchboards, panelboards, MCCs, control and instrumentation panels, starters, switches, and pushbutton stations. In addition to nameplates, control devices shall be equipped with standard collar-type legend plates.
 - 2 Control devices within enclosures shall be identified as indicated. Identification shall be similar to the subparagraph above.
 - 3 Equipment names and tag numbers, where indicated on the Drawings, shall be utilized on all nameplates.
 - 4 The CONTRACTOR shall furnish typewritten circuit directories for panelboards; circuit directory shall accurately reflect the equipment connected to each circuit.
 - 5 Generator transfer switches shall be labeled "Main" and "Generator" with 1/2" lettering.

3.5 CLEANING

- A. Before final acceptance, the electrical WORK shall be thoroughly cleaned. Exposed parts shall be thoroughly clean of cement, plaster, and other materials. Oil and grease spots shall be removed with a non-flammable cleaning solvent. Such surfaces shall be carefully wiped and all cracks and corners cleaned out. Touch-up paint shall be applied to scratches on panels and cabinets. Electrical cabinets or enclosures shall be vacuum-cleaned.
- B. CONTRACTOR shall group, coil, and tie wrap all spare cables at the bottom of the Local Control Panels. The wires shall be grouped according to the device, control panel, or MCC section they originate from. Cable groups shall be tagged according to their point of origin.
- C. All debris shall be removed from the void below the panels.
- 3.6 CONTROL PANEL WIRING

A. The CONTRACTOR shall ensure all panels are UL-listed upon completion of the WORK.

SECTION 260519 - WIRE AND CABLES

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall provide wires and cable, complete and operable, in accordance with the Contract Documents.
- 1.2 CONTRACTOR SUBMITTALS
 - A. The CONTRACTOR shall submit Shop Drawings in accordance with Section 01 33 00, and 26 05 00 Electrical Work, General.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Conductors, including grounding conductors, shall be copper. Aluminum conductor wire and cable will not be permitted. Insulation shall bear the label of Underwriters' Laboratories, Inc. (UL), the manufacturer's trademark, and identify the type, voltage, and conductor size. All conductors except flexible cords and cables, fixture wires, and conductors that form an integral part of equipment, such as motors and controllers, shall conform to the requirements of Article 310 of the National Electric Code, latest edition, for current carrying capacity. Flexible cords and cables shall conform to Article 400, and fixture wires shall conform to Article 402. Wiring shall have wire markers at each end.

2.2 LOW VOLTAGE WIRE AND CABLE

- A. Power and Lighting Wire
 - 1 Power and lighting wire shall be No. 12 copper AWG minimum size.
 - 2 Wire rated for 600 volts in duct or conduit for all power shall be:
 - a In above grade interior locations: Class B Type THWN-2
 - b In exterior, underground and below grade installations XHHW-2
 - 3 Wiring for 600 volt class power and lighting shall be as manufactured by **General Cable**, **Okonite**, or **Rome Cable**.
- B. Control Wire
 - 1 Control wire in duct or conduit shall be the same type as power and lighting wire indicated above.
 - 2 Control wiring shall be No.14, 19-strand copper AWG.
- C. Instrumentation Cable

- 1 Instrumentation cable shall be rated at 600 volts.
- 2 Individual conductors shall be No. 18 AWG stranded, tinned copper. Insulation shall be color-coded polyethylene: black-red for two-conductor cable, and black-red-white for three-conductor cable.
- 3 Instrumentation cables shall be composed of the individual conductors, an aluminum polyester foil shield, a No. 18 AWG stranded, tinned copper drain wire, and a PVC outer jacket with a thickness of 0.048-inches.
- 4 Single pair, No. 18 AWG, twisted, shielded cable shall be **Belden Part No. 9341**, or equal.
- 5 Single triad, No. 16 AWG, twisted, shielded cable shall be **Belden Part No. 1119A**, or equal.
- D. Multi-pair Control Cable Multi-pair control cable shall be 6-pair, 600V, No. 16 AWG, twisted, shielded, direct burial rated **Belden Part No. 1040A**, or equal.
- E. Cat 6 Cable: Cat 6 patch cable shall be 4-pair 24-gauge twisted pair rated to TIA/EIA 568-C.2 Category 6 and UL-listed. The CONTRACTOR shall install RJ-45 connectors as required.
- 2.3 CABLE TERMINATIONS
 - A. Compression connectors shall be **Burndy "Hi Lug", Thomas & Betts "Sta-Kon,"** or equal. Threaded connectors shall be split bolt type of high strength copper alloy. Pressure type, twist-on connectors will not be acceptable.
 - B. Pre-insulated fork tongue lugs shall be **Thomas & Betts, Burndy**, or equal.
 - C. General purpose insulating tape shall be **Scotch No. 33, Plymouth "Slip-knot,"** or equal. High temperature tape shall be polyvinyl as manufactured by **Plymouth, 3M**, or equal.
 - D. Labels for coding 600-volt wiring shall be heat-shrink plastic tubing type with machine print. Lettering shall read from left to right, and face the front of the panel. Field wires terminating at a Control Panel shall be labeled with the wire number shown on the Control Panel wiring diagrams. The CONTRACTOR shall mark all as-built drawings with wire labels.

PART 3 -- EXECUTION

- 3.1 GENERAL
 - A. The CONTRACTOR shall provide and terminate all power, control, and instrumentation conductors, except where indicated.

3.2 INSTALLATION

- A. Conductors for feeders as defined in Article 100 of the NEC shall be sized to prevent a voltage drop exceeding 2 percent at the farthest point of power distribution, and where the maximum total voltage drop on both feeders and branch circuits to the farthest connected load does not exceed 5 percent.
- B. Conductors for branch circuits as defined in Article 100 of the NEC, shall be sized to prevent a voltage drop exceeding 3 percent at the farthest connected load or combinations of such loads, and where the maximum total voltage drop on both feeders and branch circuits to the farthest connected load does not exceed 5 percent.
- C. Conductors shall not be pulled into raceway until raceway has been cleared of moisture and debris.
- D. Pulling tensions on raceway cables shall be within the limits recommended by the cable manufacturer. Wire pulling lubricant, where needed, shall be UL-approved for the cables/wires being pulled.
- E. The following wiring shall be run in separate raceways:
 - 1 24 VDC discrete signal and instrument power supply.
 - 2 4-20 mA analog signal.
 - 3 All AC circuits.
 - 4 Intrinsically safe circuits.
- F. Wire in panels, cabinets, and wireways shall be neatly grouped using nylon tie straps, and shall be fanned out to terminals.
- G. Conduit Seals: Conduit penetrating building exterior walls shall be sealed with duct seal at the end of the conduit where the conduit enters the building. Provide cloth rag backing and 1" of duct seal so duct seal can be removed in the future.

3.3 SPLICES AND TERMINATIONS

- A. General
 - 1 Wire taps and splices are not to be used unless the CONTRACTOR can convince the ENGINEER that they are essential and the ENGINEER gives written permission.
 - 2 There shall be no cable splices in underground conduits, manholes or pullboxes.
 - 3 Stranded conductors shall be terminated directly on equipment box lugs, making sure that all conductor strands are confined within the lug. Use forked-tongue lugs where equipment box lugs have not been provided.

- 4 Excess control and instrumentation wire shall be properly taped and terminated as spares.
- B. Control Wire and Cable
 - 1 Control conductors shall be spliced or terminated only on terminal strips in panels or vendor-furnished equipment.
 - 2 In terminal cabinets, junction boxes, motor control centers, and control panels, control wire and spare wire shall be terminated to terminal strips.
- C. Instrumentation Wire and Cable
 - 1 Shielded instrumentation cables shall be grounded at one end only, the receiving end (i.e., in the control panel) on a 4-20 mA system.
- D. Power Wire and Cable
 - 1 No 120/208-volt, 120/240-volt, and 480/277-volt branch circuit conductors may be spliced unless the CONTRACTOR can convince the ENGINEER that they are essential and the ENGINEER gives written permission.
- 3.4 CABLE IDENTIFICATION
 - A. General: Wires and cables shall be identified for proper control of circuits and equipment and to reduce maintenance effort.
 - B. Identification Numbers: The CONTRACTOR shall assign to each control and instrumentation wire and cable a unique identification number. Numbers shall be assigned to all conductors having common terminals and shall be shown on "as built" drawings. Identification numbers shall appear within 3 inches of conductor terminals. "Control Conductor" shall be defined as any conductor used for alarm, annunciator, or signal purposes.
 - 1 Multiconductor cable:
 - a Assign a number that shall be attached to the cable at intermediate pull boxes and at stub-up locations beneath freestanding equipment.
 - b Cable number shall form a part of the individual wire number.
 - c Individual control conductors and instrumentation cable shall be identified at pull points as described above.
 - d The instrumentation cable numbers shall incorporate the loop numbers assigned in the Contract Documents.
 - 2 All 120/208-volt system feeder cables and branch circuit conductors shall be colorcoded as follows:

- a Phase A Black
- b Phase B Red
- c Phase C Blue
- d Neutral White
- 3 The 120/240-volt system conductors shall be color-coded as follows:
- a Line 1 Black
- b Line 2 Red
- c Neutral White
- 4 The 480/277-volt system conductors shall be color-coded as follows:
 - a Phase A Brown
 - b Phase B Orange
 - c Phase C Yellow
 - d Neutral Gray
- 5 Color-coding tape shall be used where colored insulation is not available.
- a Branch circuit switch shall be Yellow.
- b Insulated ground wire shall be Green.
- c Neutral shall be White.
- 6 Color coding and phasing shall be consistent throughout the Site, bus bars at panelboards, switchboards, and motor control centers shall be connected Phase A-B-C, top to bottom, or left to right, facing connecting lugs.
- 7 General purpose AC control cables shall be Red.
- 8 General purpose DC control cables shall be Blue.
- 9 Spare cable shall be terminated on terminal screws and shall be identified with a unique number as well as with destination.
- 10 Terminal strips shall be identified by computer-printable, cloth, self-sticking marker strips attached under the terminal strip.
- 3.5 TESTING

- A. Cable Assembly and Testing: Cable assembly and testing shall comply with applicable requirements of ICEA Publication No. S-68-516 Ethylene-Propylene-Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy. Factory test results shall be submitted in accordance with Section 013300 Contractor Submittals, prior to shipment of cable. The following field tests shall be the minimum requirements:
 - 1 Power cable rated at 600 volts shall be tested with a 1000-volt megohm meter for insulation resistance between phases and from each phase to a ground using a megohmeter.
 - 2 Field testing shall be done after cables are installed in the raceways.
 - 3 Field tests shall be performed by a certified test organization acceptable to the cable manufacturer. Test results shall be submitted to the ENGINEER for review and acceptance.
 - 4 Cables showing less than 100 megohm resistance shall be replaced with a new cable or be repaired. Repair methods shall be as recommended by the cable manufacturer and shall be performed by persons certified by the industry.
- B. Continuity Test: Control and instrumentation cables shall be tested for continuity, polarity, undesirable ground, and origination. Such tests shall be performed after installation and prior to placing all wires and cables in service.

SECTION 260526 - GROUNDING

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall provide the electrical grounding system, complete and operable, in accordance with the Contract Documents.
- B. The requirements of Section 26 05 00 Electrical Work, General apply to this Section.
- C. Single Manufacturer: Like products shall be the end product of one manufacturer in order to achieve standardization of appearance, operation, maintenance, spare parts and manufacturer's services.
- 1.2 CONTRACTOR SUBMITTALS
 - A. Furnish submittals in accordance with Section 01 33 00 and Section 26 05 00 Electrical Work, General.
 - B. Shop Drawings: Manufacturer's product information for connections, clamps, and grounding system components, showing compliance with the requirements of this Section.

PART 2 -- PRODUCTS

2.1 GENERAL

- A. Components of the grounding electrode system shall be manufactured in accordance with ANSI/UL 467 Standard for Safety Grounding and Bonding Equipment, and shall conform to the applicable requirements of National Electrical Code Article 250 and local codes.
- 2.2 GROUNDING SYSTEM
 - A. Grounding loop conductors shall be bare annealed copper conductors suitable for direct burial. Conductors shall be No. 4 for 100A services, or No. 4/0 for all other service sizes, unless indicated otherwise.
 - B. Ground Rods
 - 1 Unless indicated otherwise, ground rods shall be a minimum of 3/4-inch in diameter, 10 feet long, and have a uniform covering of electrolytic copper metallically bonded to a rigid steel core. The copper to steel bond shall be corrosion resistant.
 - 2 Conform to ANSI/UL 467.
 - 3 Sectional type joined by threaded copper alloy couplings.
 - C. Buried cable-to-cable and cable-to-ground rod connections shall be made using exothermic welds by **Cadweld, Enrico Products**, or equal.

- D. Exposed grounding connectors shall be of the compression type (connector to cable), made of high copper alloy, and be manufactured specifically for the particular grounding application. The connectors shall be **Burndy, O.Z. Gedney**, or equal.
- E. Grounding clamps shall be used to bond each separately derived system to the grounding electrode conductors.
- F. Equipment Grounding Circuit Conductors
 - 1 These conductors shall be the same type and insulation as the load circuit conductors. The minimum size shall be as outlined in Table 250.122 of the National Electrical Code, unless indicated otherwise.
 - 2 Metallic conduit systems shall have equipment grounding wires as well as being equipment grounding conductors themselves.
- G. Ground clamps in concrete shall be rated for use with rebar and embedded in concrete.
- H. Manufacturers of grounding materials shall be **Copperweld, Blackburn, Burndy**, or equal.

PART 3 -- EXECUTION

- 3.1 GROUNDING
 - A. Provide a separate grounding conductor, securely grounded in each raceway independent of raceway material.
 - B. Provide a separate grounding conductor for each motor and connect at motor box. Do not use bolts securing motor box to frame or cover for grounding connectors.
 - C. Size in accordance with the NEC-Article 250 and local amendments.
 - D. Route conductors inside raceway.
 - E. Provide a green insulated wire as grounding jumper from the ground screw to a box grounding screw and, for grounding type devices, to equipment grounding conductor.
 - F. Provide a separate grounding conductor in each individual raceway for parallel feeders.
 - G. Bond cold water pipe systems and metallic building structure per NEC. Bond ALL water pipe penetrations.
 - H. Measure ground impedance in accordance with IEEE STD 81 after installation but before connecting the electrode to the remaining grounding system.
 - I. Low Voltage Grounded System (600-volt or less): A low voltage grounded system is a system where the local power supply is a transformer with the transformer secondary grounded.

- 1 Grounding system connections for a premises wired system supplied by a grounded AC service shall have a grounding electrode connector connected to the grounded service conductor at each service, in accordance with the NEC.
- 2 The grounded circuit conductor shall not be used for grounding non-current carrying parts of equipment, raceways, and other enclosures except where specifically listed and permitted by the NEC.
- J. Embedded Ground Connections
 - 1 Underground and grounding connections embedded in concrete shall be UL listed compression type ground grid connectors.
 - 2 The connection shall be made in accordance with the manufacturer's instructions.
 - 3 The CONTRACTOR shall not conceal or cover any ground connections until the ENGINEER or authorized representative has established that every grounding connection conforms to the Contract Documents and has given the CONTRACTOR written confirmation.
- K. Ground Rods
 - 1 Locations shall be as determined in the field.
 - 2 Rods forming an individual ground array shall be equal in length.
 - 3 Rod spacing shall be a minimum of the rod length.
- L. Shield Grounding
 - 1 Shielded instrumentation cable shall have its shield grounded at one end only unless Shop Drawings indicate the shield will be grounded at both ends.
 - 2 The grounding point shall be at the control panel or otherwise at the receiving end of the signal carried by the cable.
 - 3 Termination of shield drain wire shall be on its own terminal screw.
 - 4 Terminal screws shall be jumpered together using manufactured terminal block jumpers.
 - 5 Connection to the ground bus shall be via a green No. 12 conductor to the main ground bus for the panel.

SECTION 260533 - ELECTRICAL RACEWAY SYSTEMS

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall provide electrical raceway systems, complete and in place, in accordance with the Contract Documents.
- B. Local amendments to NEC require:
 - a The equipment grounding conductor run with or enclosing the circuit conductors shall be one or more or a combination of the following:
 - b A copper, aluminum, or copper-clad aluminum conductor.
 - c This conductor shall be solid or stranded; insulated, covered, or bare; and in the form of a wire or a bus bar of any shape.

1.2 DEFINITIONS

A. Raceway System – raceway system consist of conduits, wireways, fittings, junction and pull boxes, supports and labels complete and ready for conductors.

PART 2 -- PRODUCTS

- 2.1 GENERAL
 - A. Conduits, wireways, fittings, supports, labels, junction and pull boxes, and other indicated enclosures which are dedicated to the raceway system, shall comply with the requirements of this Section.

2.2 CONDUIT

- A. Galvanized Rigid Steel Conduit (GRC)
 - a Rigid steel conduit shall be mild steel, hot-dip galvanized inside and out.
 - b Rigid steel conduit shall be manufactured in accordance with ANSI C80.1 Rigid Steel Conduit, Zinc Coated, and UL-6.
 - c Manufacturers, or Equal
 - d LTV Steel;
 - e Triangle;
 - f Wheatland Tube.
 - g GRC shall be used only in interior mechanical, electrical and storage rooms.
- B. PVC-Coated Galvanized Rigid Steel Conduit (PVC-coated GRC)

- a The conduit, prior to PVC coating, shall meet the requirements for GRC conduit above.
- b A PVC coating shall be bonded to the outer surface of the galvanized conduit. The bond between the coating and the conduit surface shall be greater than the tensile strength of the coating.
- c PVC coating thickness shall be not less than 40 mils.
- d PVC-coated GRC shall be manufactured in accordance with the following standards:
- e UL-6
- f ANSI C80.1
- g NEMA RN1 PVC Externally Coated Galvanized Rigid Steel Conduit, Intermediate Metal Conduit, and where shown on the plans
- h Manufacturers, or Equal
- i Robroy;
- j Ocal.
- k PVC-coated GRC shall be used in all exterior locations, process areas, areas subject to corrosion, in spray and wash-down areas, and where shown on the drawings.
- C. Liquidtight Flexible Conduit (LFMC)
 - a Liquidtight flexible conduit (LFMC) shall be constructed of a flexible galvanized metal core with a sunlight-resistant thermoplastic outer jacket.
 - b LFMC shall be manufactured in accordance with UL-360 Steel Conduits, Liquid-Tight Flexible.
 - c Manufacturers, or Equal
 - d Anaconda, "Sealtite";
 - e Electriflex, "Liquatite".
- D. Electrical Metallic Tubing (EMT)
 - a Electrical metallic tubing shall be mild steel, hot-dip galvanized tubing complying with ANSI C80.3 and Fed.Spec. WWC-563 and shall be UL listed.
 - b Elbows, bends, and fittings shall be made from full weight materials complying with the above and shall be coated the same as electrical metallic tubing.

- c Electrical metallic tubing shall be 1/2-inch trade size or larger and shall be manufactured by Allied Tube and Conduit Corp., Triangle PWC, Inc., or approved equal.
- d. EMT conduit may be used in dry interior, non-process locations only.

2.3 FITTINGS AND BOXES

- A. General:
 - a Fittings and boxes shall follow the conduit type of which they are installed with: PVC-Coated Fittings and Boxes or stainless steel boxes shall be used with PVC-Coated GRC; galvanized malleable iron Fittings and Boxes shall be used with GRC.
 - b Cast and malleable iron fittings for use with metallic conduit shall be the threaded type with 5 full threads.
 - c Fittings and boxes shall have neoprene gaskets and non-magnetic stainless steel screws. All covers shall be attached by means of holes tapped into the body of the fitting. Covers for fittings attached by means of clips or clamps will not be acceptable.
 - d Non-explosion-proof boxes larger than standard cast or malleable types shall be 304 stainless steel, NEMA 4X.
 - e Boxes larger than standard cast or malleable types shall be 304 stainless steel, NEMA 4X.
 - f In outdoor areas, raceways shall be terminated in raintight hubs as manufactured by **Myers, O.Z. Gedney**, or equal. In other than outdoor areas, sealed locknuts and bushings shall be used.
 - g Fittings and boxes in hazardous locations shall be suitable for the Class and Division indicated or required by code.
- B. Cast Aluminum Fittings and Boxes
 - a Cast aluminum boxes and fittings shall have less than 0.40 percent copper content.
 - b Manufacturers, or Equal
 - c O.Z. Gedney;
 - d Appleton;
 - e Crouse-Hinds.
- C. Malleable Iron Fittings and Boxes
 - a Fittings and boxes for use with galvanized steel conduit shall be of malleable iron or gray-iron alloy with zinc plating with same finish as the conduit.
 - b Manufacturers, or Equal

- c O.Z. Gedney;
- d Crouse-Hinds;
- e Appleton.
- D. PVC-Coated Fittings and Boxes
 - a Fittings and boxes for use with PVC-coated GRC shall be PVC-coated and shall be products of the same manufacturer as the conduit.
 - b Fittings used for LFMC and PVC-coated systems are to be PVC-coated.
- E. Stainless Steel Boxes
 - a Stainless steel boxes shall be used with PVC-coated GRC raceway systems and where indicated on the Drawings.
 - b Stainless steel boxes shall be NEMA 4X, Type 304.
 - c Stainless steel shall be a minimum 14-gauge thickness, with a brushed finish.
 - d Doors shall have full-length stainless steel piano hinges. Non-hinged boxes are not acceptable.
 - e Manufacturers, or Equal
 - f Hoffman;
 - g Rohn;
 - h Hammond.
- 2.4 CABLE TRAYS
 - A. Cable trays are not to be used.

PART 3 -- EXECUTION

3.1 GENERAL

- A. All wiring shall be run in raceway unless indicated otherwise.
- B. Raceways shall be installed between equipment as indicated. Raceway systems shall be electrically and mechanically complete before conductors are installed. Bends and offsets shall be smooth and symmetrical, and shall be accomplished with tools designed for this purpose. Field bends are required on conduits up to 2". Factory elbows may be utilized on raceways over 2". All fittings and connections shall be made tight.
- C. Separate raceway systems shall be provided for:
 - a Analog signals

- b 24 VDC discrete signals and instrument power supply conductors
- c 120 VAC and higher wiring
- d Intrinsically safe wiring
- D. When non-loop powered instruments have only one raceway port, the CONTRACTOR may run both the analog and 24 VDC wiring in a short length of ½" LFMC to a splitter box where the wiring must then be separated into the required raceway system. The length of LFMC must be kept to the absolute minimum and must not exceed 3 feet unless written approval has been given by the ENGINEER.
- E. Where raceway routings are indicated on plan views, follow those routings to the extent possible.
- F. Routings shall be adjusted to avoid obstructions. Coordinate between trades prior to installation of raceways. Lack of such coordination shall not be justification for extra compensation, and removal and re-installation to resolve conflicts shall be by the CONTRACTOR as part of the WORK.
- G. Support rod attachment for ceiling-hung trapeze installations shall meet the seismic requirements.
- H. Exposed raceways shall be installed parallel or perpendicular to structural beams.
- I. Install expansion fittings with bonding jumpers wherever raceways cross building expansion joints.
- J. Exposed raceways shall be installed at least 1/2-inch from walls or ceilings except that at locations above finished grade where damp conditions do not prevail, exposed raceways shall be installed 1/4-inch minimum from the face of walls or ceilings by the use of clamp backs or struts.
- K. In underground facilities or NEMA 4X areas, all raceway penetrations in panels shall be bottom entry.
- L. Wherever contact with concrete or dissimilar metals can produce galvanic corrosion of equipment, suitable insulating means shall be provided to prevent such corrosion.
- M. To facilitate future expansion, boxes and fittings are to be installed when indicated on the drawings. Unused hubs are to be plugged with proprietary devices. Raceways that include future expansion provision are to be sized to accommodate any such specified wiring without exceeding the requirements of this specification.

Conduit Diameter	No. of 14- Gauge Wires	No. of 18- Gauge TWS
3/4"	8	2
1"	16	4
1-1/4"	32	7
1-1/2"	48	10
2"	72	17

N. The maximum allowable conduit fill for instrumentation and control wiring is given by the following table:

O. Note: No instrumentation or control wiring conduit is to be larger than 2 inches in diameter.

3.2 RACEWAYS

- A. Exposed raceway systems shall be of the type specified for the area installed as identified herein.
- B. Raceways concealed, or encased in concrete shall be PVC-coated GRC. Conduit shall emerge from the concrete perpendicular to the surface whenever possible.
- C. Exposed conduit shall be 3/4-inch minimum trade size. Supports shall be installed at distances required by the NEC.
- D. Conduit shall not be encased in the bottom floor slab below grade.
- E. Concrete cover for conduit and fittings shall not be less than 1-1/2 inches for concrete exposed to earth or weather, or less than 3/4-inch for concrete not exposed to weather or in contact with the ground.
- F. Raceways passing through a slab, wall, or beam shall not impair significantly the strength of the construction.
- G. Raceways embedded within a slab, wall, or beam (other than those merely passing through) shall satisfy the following:
 - a Conduits with their fittings embedded within a column shall not displace more than 4 percent of the gross area of cross section.
 - b Conduits shall not be larger in outside dimension than one third the overall thickness of slab, wall, or beam in which embedded.
 - c Raceways shall not be spaced closer than 3 outside diameters on centers.

- H. Raceways shall be placed so that cutting, bending, or displacing reinforcement from its proper location will not be required.
- I. Threads shall be coated with a conductive lubricant before assembly.
- J. Joints shall be tight, thoroughly grounded, secure, and free of obstructions in the pipe. Conduit shall be adequately reamed to prevent damage to the wires and cables inside. Strap wrenches and vises shall be used to install conduit to prevent wrench marks on conduit. Conduit with wrench marks shall be replaced.
- K. Wherever raceways enter substructures below grade, the raceways shall be sloped to drain water away from the structure. Extreme care shall be taken to avoid pockets or depressions in raceways.
- L. Connections to motors and other equipment subject to vibration shall be made with LFMC not exceeding 3-feet in length. Equipment subject to vibration that is normally provided with wiring leads shall be provided with a cast junction box for the make-up of connections. The junction box is to be independently supported and <u>not</u> left free to hang from the equipment.
- M. Raceways passing through walls or floors shall have plastic sleeves. Core drilling shall be performed in accordance with Section 26 00 00.
- N. Conduit, fittings, and boxes required in hazardous classified areas shall be suitably rated for the area and shall be provided in strict accordance with NEC requirements.
- O. Empty raceways shall be tagged at both ends to indicate the final destination. Where it is not possible to tag the raceway, destination shall be identified by a durable marking on an adjacent surface. A pull-cord shall also be installed in each empty conduit. This shall apply to conduits in floors, panels, manholes, equipment, etc.
- P. Where an underground raceway enters a structure through a concrete roof or a membrane waterproofed wall or floor, core-drill the entrance and provide a Link-Seal, or equal, sealing device. The sealing device shall be utilized with PVC-coated GRC/rigid steel conduit.
- Q. Final connections to heaters, instruments, motors, limit switches, and any equipment subject to vibration shall be made with LFMC and approved fittings. Maximum length of LFMC shall be 3 feet.
- R. Connections to solenoid valves, pilot actuators, and flood sensors shall be made with LFMC and approved fittings to a cast box with screw cover (GUA type), independently and securely supported. In no case is the device to support the cast box.

3.3 CABLE TRAYS

A. Cable trays are not to be used.

SECTION 260543 - UNDERGROUND RACEWAY SYSTEMS

PART 1 -- GENERAL

- 1.1 THE REQUIREMENT
 - A. The CONTRACTOR shall provide underground raceway systems, including trenching, backfill, compaction, and restoration, complete and in place, in accordance with the Contract Documents.
- 1.2 CONTRACTOR SUBMITTALS
 - A. Furnish submittals in accordance with Section 01 33 00, and 26 00 00 Electrical General Requirements.
 - B. Shop Drawings
 - 1 Complete catalog cuts of all conduit and fittings marked where applicable to show proposed materials and finishes.
 - C. Record Drawings
 - 1 Show routings, burial depths, locations and sizes.

PART 2 -- PRODUCTS

- 2.1 GENERAL
 - A. Fittings that are dedicated to the underground raceway system shall comply with the requirements of this Section.
- 2.2 UNDERGROUND CONDUITS
 - A. Underground raceways shall be:
 - 1 Schedule 40 HDPE. HDPE for buried horizontal runs shall be UL-Listed, compliant with NEC articles 300 and 353 and Listed to UL 651 A&B and NEMA TC-7.
 - or
 - 2 PVC-Coated GRC meeting the requirements of 26 05 33.
 - B. Identification Tape: Continuous lengths of underground warning tapes shall be installed a minimum of 12-inches above and parallel to conduits. Tape shall be 6-inches wide polyethylene film imprinted "CAUTION - ELECTRIC UTILITIES BELOW." Tape shall have non-ferrous metal foil conductor sandwiched in the tape for detection purposes. Tape shall be as manufactured by **Brady**, or equal.

PART 3 -- EXECUTION

3.1 GENERAL

- A. Underground raceways shall be installed between structures as indicated. Raceway systems shall be electrically and mechanically complete before conductors are installed. Bends and offsets shall be smooth and symmetrical, and shall be fabricated with tools designed for this purpose. Factory elbows shall be utilized wherever possible. Unless otherwise noted provide PVC-Coated GRC for vertical sweeps and risers.
- B. Raceway routing shall be adjusted to avoid obstructions.

3.2 INSTALLATION

- A. Raceways shall be installed in accordance with the criteria below:
 - 1 Raceway shall be laid on a grade line of at least 3-inches per 100-feet, sloping towards handholes or structures. Conduit shall be installed and handhole depths adjusted so that the top of the conduit is a minimum of 24-inches below grade and a minimum of 24-inches below roadways, driveways, and bike trails.
 - 2 Changes in direction of the duct envelope by more than 10 degrees horizontally or vertically shall be accomplished using factory elbows.
 - 3 Raceway shall be installed in accordance with the Manufacturer's requirements and recommendations. The bottom of trench shall be of select backfill or sand.
 - 4 Each of the completed raceways shall be cleaned by drawing through it a standard flexible mandrel one foot long and 1/4-inch smaller than the nominal size of the duct. After passing of the mandrel, a wire brush and swab shall be drawn through.
 - 5 Provide Dura-line Shur-lok II, or approved equal, fittings when converting between different raceway materials (i.e.: HDPE to PVC-Coated GRC).
- B. Raceway penetration through walls of structures and handholes below grade shall be watertight.
- C. When raceway enters a building, conduit shall transition to rigid steel PVC-coated conduit on stub-up.
- D. Where an underground raceway enters a structure through a concrete wall, provide a **Link-Seal**, or equal sealing device. The sealing device shall be utilized with plastic coated rigid steel conduit. Transition from HDPE to PVC-Coated GRC prior to building or handhole entry.

3.3 RESTORATION

- A. The CONTRACTOR shall restore all disturbed areas.
- B. Grassed areas shall be backfilled, compacted, and top-soiled and reseeded.
- C. Gravel driveways shall be restored including backfill and compaction to 95 percent density to match existing.

SECTION 262726 - WIRING DEVICES

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall provide all wiring devices, plates, and nameplates in accordance with the Contract Documents.
- B. The requirements of Section 26 00 00 Electrical General Requirements apply to this Section.
- C. Single Manufacturer: Like products shall be the end product of one manufacturer in order to achieve standardization of appearance, operation, maintenance, spare parts, and manufacturer's services.
- 1.2 CONTRACTOR SUBMITTALS
 - A. Furnish submittals in accordance with Section 01 33 00.
 - B. Shop Drawings
 - 1 Complete catalog cuts of switches, receptacles, enclosures, covers, and appurtenances, marked to clearly identify proposed materials.
 - 2 Documentation showing that proposed materials comply with the requirements of NEC and UL.
 - 3 Documentation of the manufacturer's qualifications.

PART 2 -- PRODUCTS

- 2.1 GENERAL
 - A. All devices shall carry the UL label.
 - B. General purpose duplex receptacles and toggle switch handles shall be brown everywhere except in finished rooms where they shall be ivory. Special purpose receptacles shall have a body color as indicated. Receptacles and switches shall conform to Federal Specifications W-C-596E and W-S-896E, respectively.
- 2.2 GENERAL PURPOSE RECEPTACLES
 - A. Duplex receptacles rated 120-volt, 20 amps shall be polarized 3-wire type for use with 3-wire cord with grounded lead and 1 designated stud shall be permanently grounded to the conduit system (NEMA 5-20R). Duplex 120-volt receptacles shall be G.E. 5362, Hubbell 5362, or equal. Single receptacles shall be G.E. 4102, Hubbell 4102, or equal.

B. Ground-fault circuit interrupting receptacles (GFCI's) shall be installed at the locations indicated. GFCI's shall be rated 125-volt, 20 amps and shall be Hubbell GFTR20, or equal. Downstream GFCI protection through the use of feed-thru receptacles is not acceptable.

2.3 ENCLOSURES AND COVERS

- A. Surface mounted switches and receptacles shall be in FS or FD type cast device boxes.
- B. Receptacles in exterior locations shall be with s-hinged cover/enclosure marked "Suitable for Wet Locations when in use" and "UL Listed." There shall be a gasket between the enclosure and the mounting surface and between the hinged cover and mounting plate/base. The cover shall be TayMac Specification Grade, or equal, of metallic construction.

PART 3 -- EXECUTION

3.1 GROUNDING

- A. Ground all devices, including switches and receptacles, in accordance with NEC Article 250 and Section 26 05 26 Grounding.
- B. Ground switches and associated metal plates through switch mounting yoke, outlet box, and raceway system.
- C. Ground flush receptacles and their metal plates through positive ground connections to outlet box and grounding system. Maintain ground to each receptacle by spring-loaded grounding contact to mounting screw or by grounding jumper, each making positive connection to outlet box and grounding system at all times.
- 3.2 FIELD TESTING
 - A. Provide checkout, field, and functional testing of wiring devices in accordance with Section 26 00 00 Electrical General Requirements.
 - B. Test each receptacle for polarity and ground integrity with a standard receptacle tester.

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 -- GENERAL

1.1 SUMMARY

A. This Section describes general requirements, products, and methods of execution relating to overcurrent protective devices approved for use on this project. Type, duty rating and characteristics, fault interrupting capability and coordination requirements shall be determined from the plans.

1.2 RELATED WORK

- A. The work of the following Sections is related to the work of this Section. Other Sections, not referenced below, may also be related to this work. It is the Contractor's responsibility to perform all the work required by the Contract Documents.
 - 1. Division 26 00 00 Electrical General Requirements

1.3 SUBMITTALS

- A. In accordance with the requirements of Section 01 33 00, submit the following Project Data:
 - 1. Descriptive literature bulletins, and catalog cuts of the equipment.
 - 2. Materials of construction.
 - 3. Complete wiring diagrams.
 - 4. Complete installation instructions, with points of electrical connection requirements clearly shown.
 - 5. Performance curves.

1.4 QUALITY ASSURANCE

A. Devices shall be the latest approved design as manufactured by a nationally recognized manufacturer and in conformity with applicable standards and UL listed.

PART 2 -- PRODUCTS

2.1 MOLDED CASE CIRCUIT BREAKERS

A. Molded case circuit breakers shall be suitable for individual as well as panelboard mounting. They shall be bolt-on type, unless "plug-on" type specifically allowed.

- B. The breakers shall meet NEMA and/or UL specifications as applicable to frame and size, standard rating and interrupting capability. Breakers installed in panelboards shall have short circuit interrupt ratings that match those of the panelboard.
- C. The breakers shall be one-, two-, or three-pole as scheduled, operate manually for normal ON-OFF switching and automatically under overload and short circuit conditions.
- D. Operating handle shall open and close all poles simultaneously on a multi-pole breaker. Operating mechanism shall be trip-free so that contacts cannot be held closed against abnormal overcurrent or short circuit condition.

PART 3 -- EXECUTION

- 3.1 INSTALLATION
 - A. Size devices as required by the load being served or as shown on the drawings.

26 32 13.13 - DIESEL-ENGINE-DRIVEN GENERATOR

PART 1 -- GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes providing a packaged engine-generator set suitable for use in mission critical applications with the features as specified and indicated. The engine generator will be used as the Standby power source for the system, but shall be capable of providing reliable power with no run-time limitations while the primary source of power is unavailable.

1.3 SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:
 - 1 Thermal damage curve for generator.
 - 2 Time-current characteristic curves for generator protective device.
 - 3 Sound test data, based on a free field requirement.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, and location and size of each field connection.
 - 1 Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
 - 2 Wiring Diagrams: Control interconnection, Customer connections.
- C. Certifications:
 - 1 Submit statement of compliance which states the proposed product(s) is certified to the emissions standards required by the location for EPA, stationary non-emergency application.
- 1.4 INFORMATIONAL SUBMITTALS
 - A. Source quality-control test reports.
 - 1 Certified summary of prototype-unit test report. See requirements in Part 2 "Source Quality Control" Article Part A. Include statement indicating torsional compatibility of components.

- 2 Certified Test Report: Provide certified test report documenting factory test per the requirements of this specification, as well as certified factory test of generator set sensors per NFPA110 level 2.
- 3 List of factory tests to be performed on units to be shipped for this Project.
- 4 Report of exhaust emissions and compliance statement certifying compliance with applicable regulations.
- B. Warranty:
 - 1 Manufacturer shall provide a one year warranty on the generator assembly and associated components. Warranty shall start after final acceptance testing has been completed and signed off by the OWNER.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- B. Manufacturer Qualifications: A qualified manufacturer having produced similar products for a minimum of ten (10) years. Maintain, within Anchorage, a service center capable of providing training, parts, and emergency maintenance repairs.
- C. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.
- D. Comply with NFPA 37 (Standard For the Installation and Use of Stationary Combustion Engines and Gas Turbines).
- E. Comply with NFPA 70 (National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702).
- F. Comply with NFPA 110 (Emergency and Standby Power Systems) requirements for Level 2 standby power supply system.

1.6 PROJECT CONDITIONS

- A. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
 - 1 Ambient Temperature: -1.1 deg C (30.0 deg F) to 32.2 deg C (90.0 deg F).
 - 2 Relative Humidity: 0 to 95 percent.
 - 3 Altitude: Sea level to 500.0 feet (152.4 m).
1.7 WARRANTY

- A. Base Warranty: Manufacturer shall provide base warranty coverage on the material and workmanship of the generator set for a minimum of twelve (12) months for Standby product from registered commissioning and start-up.
- B. Extended Warranty: Manufacturer shall offer extended coverage of 2 years from date of registered commissioning and start-up.

PART 2 -- PRODUCTS

- 2.1 MANUFACTURERS
 - A. Manufacturers: The basis for this specification is Cummins Power Generation equipment, approved equals may be considered if equipment performance is shown to meet the requirements herein.

2.2 ENGINE-GENERATOR SET

- A. Factory-assembled and -tested, engine-generator set.
- B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.
 - 1 Rigging Information: Indicate location of each lifting attachment, generator-set center of gravity, and total package weight in submittal drawings.
 - 2 Generator set shall be mounted on a sub-base fuel tank sized for 48 hrs of run-time at full load.
- C. Capacities and Characteristics:
 - 1 Power Output Ratings: Electrical output power rating for Standby operation of not less than 40.0kW, at 80 percent lagging power factor, 277/480V, Series Wye, 3 phase, 4-wire, 60 hertz.
 - 2 Alternator shall be capable of accepting maximum 70% of full load in a single step and be capable of recovering to a minimum of 90% of rated no load voltage following the application of the specified kVA load at near zero power factor applied to the generator set.
 - 3 Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component. The engine-generator nameplate shall include information of the power output rating of the equipment.
- D. Generator-Set Performance:
 - 1 Steady-State Voltage Operational Bandwidth: 0.5 percent of rated output voltage from no load to full load.
 - 2 Transient Voltage Performance: Not more than 20 percent variation for 50 percent stepload increase or decrease. Voltage shall recover and remain within the steady-state

DIESEL-ENGINE-DRIVEN GENERATOR ISSUED FOR CONSTRUCTION PAGE 263213.13-3 MARCH 2018 operating band within 5 seconds. On application of a 100% load step the generator set shall recover to stable voltage within 10 seconds.

- 3 Steady-State Frequency Operational Bandwidth: 0.25 percent of rated frequency from no load to full load.
- 4 Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
- 5 Transient Frequency Performance: Not more than 15 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within 5 seconds. On application of a 100% load step the generator set shall recover to stable frequency within 10 seconds.
- 6 Output Waveform: At full load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for any single harmonic. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50.
- 7 Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 8 seconds without damage to generator system components. For a 1-phase, bolted short circuit at system output terminals, system shall regulate both voltage and current to prevent over-voltage conditions on the non-faulted phases.
- 8 Start Time: Comply with NFPA 110, Level 2, system requirements.
- 9 Ambient Condition Performance: Engine generator shall be designed to allow operation at full rated load in an ambient temperature under site conditions, based on highest ambient condition. Ambient temperature shall be as measured at the air inlet to the engine generator for enclosed units, and at the control of the engine generator for machines installed in equipment rooms.

2.3 ENGINE

- A. Fuel: ASTM D975 #1 Diesel Fuel
- B. Rated Engine Speed: 1800RPM.
- C. Lubrication System: The following items are mounted on engine or skid:
 - 1 Lube oil pump: shall be positive displacement, mechanical, full pressure pump.
 - 2 Filter and Strainer: Provided by the engine manufacturer of record to provide adequate filtration for the prime mover to be used.
 - 3 Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.
- D. Engine Fuel System: The engine fuel system shall be installed in strict compliance to the engine manufacturer's instructions

- E. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.
- F. Governor: Adjustable isochronous, with speed sensing. The governing system dynamic capabilities shall be controlled as a function of engine coolant temperature to provide fast, stable operation at varying engine operating temperature conditions. The control system shall actively control the fuel rate as appropriate to the state of the engine generator. Fuel rate shall be regulated as a function of starting, accelerating to start disconnect speed, accelerating to rated speed, and operating in various isochronous states.
- G. Cooling System: Closed loop, liquid cooled
 - 1 The generator set manufacturer shall provide prototype test data for the specific hardware proposed demonstrating that the machine will operate at rated standby load in an outdoor ambient condition of 40 deg C.
 - 2 Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
 - 3 Size of Radiator overflow tank: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
 - 4 Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
 - 5 Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
 - 6 Duct Flange: Generator sets installed indoors shall be provided with a flexible radiator duct adapter flange.
- H. Muffler/Silencer: Selected with performance as required to meet critical sound requirements, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
- I. Air-Intake Filter: Engine-mounted air cleaner with replaceable dry-filter element and restriction indicator.
- J. Starting System: 12 or 24V, as recommended by the engine manufacturer; electric, with negative ground.
 - 1 Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
 - 2 Cranking Cycle: As required by NFPA 110 for level 2 systems.
 - 3 Battery Cable: Size as recommended by engine manufacturer for cable length as required. Include required interconnecting conductors and connection accessories.

- 4 Battery Compartment: Factory fabricated of metal with acid-resistant finish.
- 5 Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation. The battery charging alternator shall have sufficient capacity to recharge the batteries with all parasitic loads connected within 4 hours after a normal engine starting sequence.
- 6 Battery Chargers: Unit shall comply with UL 1236, provide fully regulated, constant voltage, current limited, battery charger for each battery bank. It will include the following features:
 - a Operation: Equalizing-charging rate based on generator set manufacturer's recommendations shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
 - b Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 20 deg C to plus 40 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
 - c Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
 - d Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
 - e Provide LED indication of general charger condition, including charging, faults, and modes. Provide a LCD display to indicate charge rate and battery voltage. Charger shall provide relay contacts for fault conditions as required by NFPA110.
 - f Enclosure and Mounting: Battery charger shall by mounted internally to the engine generator weatherproof enclosure.
 - g Battery Charger shall be as manufacturer by SENS Inergenius or equal.

2.4 OUTDOOR GENERATOR-SET ENCLOSURE

- A. Description: Weather Protective Sound Attenuated Aluminum housing. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Instruments, control, and battery system shall be mounted within enclosure.
- B. Construction:
 - 1 Hinged Doors: With padlocking provisions. Restraint/Hold back hardware to prevent excessive door swing and to keep door open at 180 degrees during maintenance. Rain lips over all doors.

- 2 Exhaust System:
 - a Muffler Location: Within enclosure.
- 3 Hardware: All hardware and hinges shall be stainless steel.
- 4 Wind Rating: Wind rating shall be 150 mph
- 5 Mounting Base: Suitable for mounting on sub-base fuel tank or housekeeping pad.
- 6 A weather protective enclosure shall be provided which allows the generator set to operate at full rated load with a static pressure drop equal to or less than 0.5 inches of water.
- C. Engine Cooling Airflow through Enclosure: Housing shall provide ample airflow for engine generator operation at rated load in an ambient temperature of 40 deg C.
 - 1 Louvers: Fixed-engine, cooling-air inlet and discharge.
- D. Sound Performance: Reduce the sound level of the engine generator while operating at full rated load to a maximum of 68.4 dBA measured at any location 23ft/7 m from the engine generator in a free field environment.
- 2.5 ENGINE ACCESSORY HEATERS:
 - A. Engine Oil Pan with thermostat, 120V, 400Watt
 - B. Engine Battery Blanket, 120V, 80Watt
 - C. Engine Coolant/Block heater, 120V,
 - D. Alternator end strip heater, 120V
 - E. Control Strip heater, 120V
- 2.6 CONTROL AND MONITORING
 - A. Engine generator control shall be microprocessor based and provide automatic starting, monitoring, protection and control functions for the unit.
 - B. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. (Switches with different configurations but equal functions are acceptable.) When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of the local (generator set-mounted) and/or remote emergency-stop switch also shut down generator set.
 - C. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts generator set. The off position of same

switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of the local (generator set-mounted) and/or remote emergency-stop switch also shuts down generator set.

- D. Configuration: Operating and safety indications, protective devices, system controls, engine gages and associated equipment shall be grouped in a common control and monitoring panel. Mounting method shall isolate the control panel from generator-set vibration. AC output power circuit breakers and other output power equipment shall be mounted in the control enclosure.
- E. Indicating and Protective Devices and Controls:
 - 1 AC voltmeter (3-phase, line to line and line to neutral values).
 - 2 AC ammeter (3-phases).
 - 3 AC frequency meter.
 - 4 AC kW output (total and for each phase). Display shall indicate power flow direction.
 - 5 AC kVA output (total and for each phase). Display shall indicate power flow direction.
 - 6 AC Power factor (total and for each phase). Display shall indicate leading or lagging condition.
 - 7 Ammeter-voltmeter displays shall simultaneously display conditions for all three phases.
 - 8 Emergency Stop Switch: Switch shall be a red "mushroom head" pushbutton device complete with lock-out/tag-out provisions. Depressing switch shall cause the generator set to immediately stop the generator set and prevent it from operating.
 - 9 Fault Reset Switch: Supply a dedicated control switch to reset/clear fault conditions.
 - 10 DC voltmeter (alternator battery charging).
 - 11 Engine-coolant temperature gauge.
 - 12 Engine lubricating-oil pressure gauge.
 - 13 Running-time meter.
 - 14 Generator-voltage and frequency digital raise/lower switches. Rheostats for these functions are not acceptable. The control shall provide adjustment of these parameters in a range of plus or minus 5% of the voltage and frequency operating set point (not nominal voltage and frequency values.) The voltage and frequency adjustment functions shall be disabled when the paralleling breaker is closed.
 - 15 Fuel tank derangement alarm.
 - 16 Fuel tank high-level shutdown of fuel supply alarm.

- 17 AC Protective Equipment: The control system shall include over/under voltage, reverse kVAR, reverse kW, over load (kW) short circuit, over current, loss of voltage reference, and over excitation shut down protection. There shall be a ground fault alarm for generator sets rated over 1000 amps, overload warning, and overcurrent warning alarm.
- 18 Status LED indicating lamps to indicate remote start signal present at the control, existing shutdown condition, existing alarm condition, not in auto, and generator set running.
- 19 Dry contacts for remote status monitoring. Provide 10 amp, 120VAC rated contacts for not in auto, generator common alarm and generator running.
- 20 A graphical display panel with appropriate navigation devices shall be provided to view all information noted above, as well as all engine status and alarm/shutdown conditions (including those from an integrated engine emission control system). The display shall also include integrated provisions for adjustment of the gain and stability settings for the governing and voltage regulation systems.
- 21 Panel lighting system to allow viewing and operation of the control when the generator room or enclosure is not lighted.
- 22 Data Logging: The control system shall log the latest 20 different alarm and shut down conditions, the total number of times each alarm or shutdown has occurred, and the date and time the latest of these shutdown and fault conditions occurred.
- 23 DC control Power Monitoring: The control system shall continuously monitor DC power supply to the control, and annunciate low or high voltage conditions. It shall also provide an alarm indicating imminent failure of the battery bank based on degraded voltage recover on loading (engine cranking).

2.7 GENERATOR OVERCURRENT AND FAULT PROTECTION

- A. Generator Overcurrent Protection: The generator set shall be provided with a UL Listed/CSA Certified protective device that is coordinated with the alternator provided to prevent damage to the generator set on any possible overload or overcurrent condition external to the machine. The protective device shall be listed as a utility grade protective device under UL category NRGU. The control system shall be subject to UL follow-up service at the manufacturing location to verify that the protective system is fully operational as manufactured. Protector shall perform the following functions:
 - 1 Initiates a generator kW overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.
 - 2 Under single phase or multiple phase fault conditions, or on overload conditions, indicates an alarm condition when the current flow is in excess of 110% of rated current for more than 10 seconds.
 - 3 Under single phase or multiple phase fault conditions, operates to switch off alternator excitation at the appropriate time to prevent damage to the alternator.

- 4 The operator panel shall indicate the nature of the fault condition as either a short circuit or an overload.
- 5 Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot greater than 120% of nominal voltage.
- 6 The protective system provided shall not include an instantaneous trip function.
- 2.8 GENERATOR OUTPUT CIRCUIT BREAKER
 - A. The generator shall be provided with a thermal magnetic trip output circuit breaker with current rating as shown on the drawings.

2.9 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

- A. Comply with NEMA MG 1.
- B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.
- C. Electrical Insulation: Class H
- D. Temperature Rise: 125 environment.
- E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, over speed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
- F. Permanent Magnet Generator (PMG) shall provide excitation power for optimum motor starting and short circuit performance.
- G. Enclosure: Drip-proof.
- H. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified. The voltage regulation system shall be microprocessor-controlled, 3-phase true RMS sensing, full wave rectified, and provide a pulse-width modulated signal to the exciter. No exceptions or deviations to these requirements will be permitted.
- I. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
- J. Subtransient Reactance: 12 percent maximum, based on the rating of the engine generator set.

2.10 FUEL OIL STORAGE, SUB-BASE FUEL TANK

- A. Comply with NFPA 30.
- B. Sub-base-mounted fuel oil tank: provide a double wall secondary containment type subbase fuel storage tank. The tank shall be constructed of corrosion resistant steel and shall be UL 142 listed and labeled. The fuel tank shall include the following features:
 - 1 Capacity: 48 hour(s) of continuous operation at 100% rated power output.

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- 2 Tank rails and lifting eyes shall be rated for the full dry weight of the tank and genset.
- 3 Electrical stub-up(s) as required.
- 4 Normal and emergency vents.
- 5 Mechanical fuel level gauge.
- 6 High and low level switches and level transducer.
- 7 Leak detector switch.
- 8 Sub-base tank shall include welded steel containment basin, sized at a minimum of 110% of the tank capacity to prevent escape of fuel into the environment in the event of a tank rupture.
- 9 Fill port with overfill prevention valve.
- 10 Five (5) gallon fill/spill dam or bucket.

2.11 VIBRATION ISOLATION DEVICES

- A. Vibration Isolation: Generators installed on grade shall be provided with spring isolation integral to the generator.
- 2.12 FINISHES
 - A. Components: Powder-coated and baked over corrosion-resistant pretreatment and compatible primer. Manufacturer's standard color or as directed on the drawings.

2.13 SOURCE QUALITY CONTROL

- A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
 - 1 Tests: Comply with NFPA 110, Level 2 Energy Converters. In addition, the equipment engine, skid, cooling system, and alternator shall have been subjected to actual prototype tests to validate the capability of the design under the abnormal conditions noted in NFPA110. Calculations and testing on similar equipment which are allowed under NFPA110 are not sufficient to meet this requirement.
- B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:
 - 1 Test engine generator set manufactured for this Project to demonstrate compatibility and functionality.
 - 2 Full load run.
 - 3 Maximum power.

- 4 Voltage regulation.
- 5 Steady-state governing.
- 6 Single-step load pickup.
- 7 Simulated safety shutdowns.
- 8 Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.

PART 3 -- EXECUTION

3.1 INSTALLATION

- A. Comply with packaged engine-generator manufacturers' written installation, application, and alignment instructions and with NFPA 110.
- B. Equipment shall be installed by the contractor in accordance with final submittals and contract documents. Installation shall comply with applicable state and local codes as required by the authority having jurisdiction. Install equipment in accordance with manufacturer's instructions and instructions included in the listing or labeling of UL listed products.
- C. Installation of equipment shall include furnishing and installing all interconnecting wiring between all major equipment provided for the on-site power system. The contractor shall also perform interconnecting wiring between equipment sections (when required), under the supervision of the equipment supplier.
- D. Equipment shall be installed on concrete housekeeping pads. Equipment shall be permanently fastened to the pad in accordance with manufacturer's instructions and seismic requirements of the site.
- E. Equipment shall be initially started and operated by representatives of the manufacturer. All protective settings shall be adjusted as instructed by the consulting engineer.
- F. All equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired prior to final system testing. Equipment shall be thoroughly cleaned to remove all dirt and construction debris prior to initial operation and final testing of the system.
- G. On completion of the installation by the electrical contractor, the generator set supplier shall conduct a site evaluation to verify that the equipment is installed per manufacturer's recommended practice.

3.2 ON-SITE ACCEPTANCE TEST

A. The complete installation shall be tested to verify compliance with the performance requirements of this specification following completion of all site work. Testing shall be conducted by representatives of the manufacturer, with required fuel supplied by Contractor. The Engineer shall be notified in advance and shall have the option to witness

the tests. The generator set manufacturer shall provide a site test specification covering the entire system.

- B. Prior to start of active testing, all field connections for wiring, power conductors, and bus bar connections shall be checked for proper tightening torque.
- C. Installation acceptance tests to be conducted on site shall include a "cold start" test, a two hour full load (resistive) test, and a one-step rated load pickup test in accordance with NFPA 110. Provide a resistive load bank and make temporary connections for full load test.
- D. Perform a power failure test on the entire installed system. This test shall be conducted by opening the power supply from the utility service, and observing proper operation of the system for at least 2 hours. Coordinate timing and obtain approval for start of test with site personnel.

3.3 TRAINING

A. The equipment supplier shall provide training for the facility operating personnel covering operation and maintenance of the equipment provided. The training program shall be not less than 4 hours in duration, and the class size shall be limited to up to 5 persons. Training dates shall be coordinated with the facility owner.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

3.5 SERVICE AND SUPPORT

- A. The generator set supplier shall maintain service parts inventory for the entire power system at a central location which is accessible to the service location 24 hours per day, 365 days per year. The inventory shall have a commercial value of \$3 million or more. The manufacturer of the generator set shall maintain a central parts inventory to support the supplier, covering all the major components of the power system, including engines, alternators, control systems, paralleling electronics, and power transfer equipment.
- B. The generator set shall be serviced by a local service organization that is trained and factory certified in generator set service. The supplier shall maintain an inventory of critical power system replacement parts in the local service location. Service vehicles shall be stocked with critical replacement parts. The service organization shall be on call 24 hours per day, 365 days per year. The service organization shall be physically located within Alaska.
- C. The manufacturer shall maintain model and serial number records of each generator set provided for at least 20 years.

3.6 SERVICE AGREEMENT:

- A. The supplier shall include in the base price, a one-year service agreement. The maintenance shall be performed by factory authorized service technicians capable of servicing the engine generator set. This agreement shall include the following:
 - 1 Generator supplier must have an in-house rental fleet with equipment sized to back up this project site.
 - 2 All engine maintenance as recommended by the service manual.
 - 3 All electrical controls maintenance and calibrations as recommended by the manufacturer.
 - 4 All auxiliary equipment as a part of the emergency systems.
 - 5 The supplier shall guarantee emergency service.
 - 6 All expendable maintenance items are to be included in this agreement.
 - 7 A copy of this agreement and a schedule shall be given to the Owner at the time of his acceptance, showing what work is to be accomplished and when.

END OF SECTION

SECTION 263623 - AUTOMATIC TRANSFER SWITCH

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. Furnish and install a closed transition transfer switch (CTTS) with number of poles, amperage, voltage, withstand, and close-on ratings as shown on the plans. Each automatic transfer switch shall consist of an inherently double throw power transfer switch mechanism and a microprocessor controller to provide automatic operation. All transfer switches and controllers shall be the products of the same manufacturer.

1.2 CODES AND STANDARDS

- A. The automatic transfer switches and controls shall conform to the requirements of:
 - 1 UL 1008 Standard for Transfer Switch Equipment
 - 2 IEC 947-6-1 Low-voltage Switchgear and Controlgear; Multifunction equipment; Automatic Transfer Switching Equipment
 - 3 NFPA 70 National Electrical Code
 - 4 NFPA 110 Emergency and Standby Power Systems
 - 5 IEEE Standard 446 IEEE Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
 - 6 NEMA Standard ICS10-1993 (formerly ICS2-447) AC Automatic Transfer Switches
 - 7 UL 508 Industrial Control Equipment

PART 2 -- PRODUCTS

- 2.1 MECHANICALLY HELD TRANSFER SWITCH
 - A. The transfer switch shall be electrically operated and mechanically held. The electrical operator shall be a momentarily energized, single-solenoid mechanism. Main operators which include overcurrent disconnect devices, linear motors or gears shall not be acceptable. The switch shall be mechanically interlocked to ensure only two possible positions, normal or emergency.
 - B. The switch shall be positively locked and unaffected by momentary outages. All main contacts shall be silver composition. Inspection of all contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors.
 - C. Designs utilizing components of molded-case circuit breakers, contactors, or parts thereof, which are not intended for continuous duty, repetitive switching or transfer between two active power sources, are not acceptable.

2.2 MICROPROCESSOR CONTROLLER

- A. The controller's sensing and logic shall be provided by a single built-in microprocessor.
- B. A single controller shall provide twelve selectable nominal voltages. Voltage sensing shall be true RMS type and shall be accurate to \pm 1% of nominal voltage. Frequency sensing shall be accurate to \pm 0.2%. The panel shall be capable of operating over a temperature range of -20 to +60 degrees C and storage from -55 to +85 degrees C.
- C. The controller shall be connected to the transfer switch by an interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the controller to be disconnected from the transfer switch for routine maintenance. Interfacing relays shall be industrial grade plug-in type with dust covers. The panel shall be enclosed with a protective cover and be mounted separately from the transfer switch unit.
- D. All customer connections shall be wired to a common terminal block to simplify fieldwiring connections.
- E. The controller shall meet or exceed the requirements for Electromagnetic Compatibility (EMC) as follows:
 - 1 EN 55011:1991 Emission standard Group 1, Class A
 - 2 EN 50082-2:1995 Generic immunity standard, from which:
 - 3 EN 61000-4-2:1995 Electrostatic discharge (ESD) immunity
 - 4 ENV 50140:1993 Radiated Electro-Magnetic field immunity
 - 5 EN 61000-4-4:1995 Electrical fast transient (EFT) immunity
 - 6 EN 61000-4-5:1995 Surge transient immunity
 - 7 EN 61000-4-6:1996 Conducted Radio-Frequency field immunity
 - 8 IEEE472 (ANSI C37.90A) Ring Wave Test.

2.3 ENCLOSURE

- A. The ATS shall be furnished with a NEMA 1 rated, lockable, dead front enclosure, unless otherwise shown on the Contract Drawings.
- B. There are no penetrations allowed in door.

2.4 CONTROLLER DISPLAY AND KEYPAD

A. A four line, 20 character LCD display and keypad shall be an integral part of the controller for viewing all available data and setting desired operational parameters.

2.5 VOLTAGE, FREQUENCY AND PHASE ROTATION SENSING

A. Voltage and frequency on both the normal and emergency sources (as noted below) shall be continuously monitored, with the following pickup, dropout, and trip setting capabilities (values shown as % of nominal):

Parameter	Sources	Dropout / Trip	Pickup / Reset
Undervoltage	N&E, 3φ	70 to 98%	85 to 100%
Overvoltage	N&E, 3∳	102 to 115%	2% below trip
Underfrequency	N&E	85 to 98%	90 to 100%
Overfrequency	N&E	102 to 110%	2% below trip
Voltage unbalance	N&E	5 to 20%	1% below dropout

- B. Voltage and frequency settings shall be field adjustable in 1% increments either locally with the display and keypad or remotely via serial communications port access.
- C. The controller shall be capable of sensing the phase rotation of both the normal and standby sources. The source shall be considered unacceptable if the phase rotation is not the preferred rotation selected (ABC or CBA).
- D. Source status screens shall be provided for both normal and emergency to provide digital readout of voltage on all 3 phases, frequency, and phase rotation.

2.6 TIME DELAYS

- A. An adjustable time delay of 0 to 6 seconds shall be provided to override momentary normal source outages and delay all transfer and engine starting signals.
- B. A time delay shall be provided on transfer to standby, adjustable from 0 to 60 minutes, for controlled timing of transfer of loads to emergency.
- C. Two time delay modes (which are independently adjustable) shall be provided on retransfer to normal. One time delay shall be for actual normal power failures and the other for the test mode function. The time delays shall be adjustable from 0 to 60 minutes. Time delay shall be automatically bypassed if the standby source fails and the normal source is acceptable.
- D. A time delay shall be provided on shut down of engine generator for cool down, adjustable from 0 to 60 minutes.
- E. All time delays shall be adjustable in 1 second increments using the LCD display and keypad.

2.7 ADDITIONAL FEATURES

- A. A SPDT contact, rated 5 amps at 30 VDC, shall be provided for a low-voltage engine start signal. The start signal shall prevent dry cranking of the engine by requiring the generator set to reach proper output, and run for the duration of the cool down setting, regardless of whether the normal source restores before the load is transferred.
- B. Auxiliary contacts, rated 10 amps, 250 VAC shall be provided consisting of one contact, closed when the ATS is connected to the normal source and one contact closed, when the ATS is connected to the standby source. An additional auxiliary normally closed contact shall be provided that will open when loss of normal power is detected.
- C. LED indicating lights shall be provided; one to indicate when the ATS is connected to the normal source (green) and one to indicate when the ATS is connected to the standby source (red).
- D. LED indicating lights shall be provided and energized by controller outputs. The lights shall provide true source availability of the normal and standby sources, as determined by the voltage sensing trip and reset settings for each source.
- E. The CTTS shall transfer the load without interruption (closed transition) by momentarily connecting both sources of power only when both sources are present and acceptable. The maximum interconnection time is 100 milliseconds. The CTTS shall operate as a conventional open transition transfer switch when a power source feeding the load fails.
- F. The controller shall be capable of accepting a normally open contact that will allow the transfer switch to function in a non-automatic mode using an external control device.
- G. Self-Diagnostics: The controller shall contain a diagnostic screen for the purpose of detecting system errors. This screen shall provide information on the status input signals to the controller which may be preventing load transfer commands from being completed.
- H. Communications Interface: Contacts shall be provided for status communication including: Normal power available, Standby Power available, Switch position, Switch not in Auto, Common Alarm. The controller shall be capable of interfacing through an optional serial communication module.
- I. Data Logging: The controller shall have the ability to log time and date stamped data and to maintain the last 99 events in the event of total power loss, including:
 - 1 Event Logging
 - a Data and time and reason for transfer normal to emergency.
 - b Data and time and reason for transfer emergency to normal.
 - c Data and time and reason for engine start.
 - d Data and time engine stopped.
 - e Data and time emergency source available.

- f Data and time emergency source not available.
- 2 Statistical Data
 - a Total number of transfers.
 - b Total number of transfers due to source failure.
 - c Total number of days controller is energized.
 - d Total number of hours both normal and emergency sources are available.
- 2.8 WITHSTAND AND CLOSING RATINGS
 - A. The ATS shall be rated to close on and withstand the available RMS symmetrical short circuit current at the ATS terminals as shown on the drawings.
 - B. The ATS shall be UL listed in accordance with UL 1008 and be labeled in accordance with that standard's 1½ and 3 cycle, long-time ratings.
- 2.9 ACCEPTABLE MANUFACTURERS
 - A. Automatic transfer switches shall be **ASCO 7000 Series**, or equal.

PART 3 -- EXECUTION

- 3.1 TESTS AND CERTIFICATION
 - A. The complete ATS shall be factory tested to ensure proper operation of the individual components and correct overall sequence of operation and to ensure that the operating transfer time, voltage, frequency and time delay settings are in compliance with the specification requirements.
 - B. The ATS manufacturer shall be certified to ISO 9001 International Quality Standard and the manufacturer shall have third party certification verifying quality assurance in design/development, production, installation and servicing in accordance with ISO 9001.

- END OF SECTION -

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Protecting existing vegetation to remain.
 - 2. Removing existing vegetation.
 - 3. Clearing and grubbing.
 - 4. Stripping and stockpiling topsoil.
 - 5. Removing above- and below-grade site improvements.
 - 6. Disconnecting, capping or sealing, removing site utilities and abandoning site utilities in place.
 - 7. Temporary erosion and sedimentation control measures.
- B. Related Sections:
 - 1. Section 011000 "Summary of Work" for temporary utility services, construction and support facilities, and temporary erosion- and sedimentation-control measures.

1.3 DEFINITIONS

- A. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.
- B. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow.
- C. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 MATERIAL OWNERSHIP

A. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 INFORMATIONAL SUBMITTALS

- A. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.
 - 1. Use sufficiently detailed photographs or videotape.
 - 2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.
- B. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.6 PROJECT CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing 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.
 - 3. All necessary closures shall be closely coordinated with the City, State, Engineer, and emergency services.
- B. Improvements on Adjoining Property: Authority for performing site clearing 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/Owner.
- C. Salvageable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.
- D. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.
- E. Do not commence site clearing operations until temporary erosion- and sedimentationcontrol and plant-protection measures are in place.
- F. Soil Stripping, Handling, and Stockpiling: Perform only when the topsoil is dry or slightly moist.

None

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Protect existing site improvements to remain from damage during construction.
 - 1. Restore damaged improvements to their original condition, as acceptable to Owner.
- 3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL
 - A. The CONTRACTOR shall be responsible for obtaining and maintaining a Stormwater Pollution Prevention Plan, if necessary.
 - B. Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion and sedimentation control Drawings and requirements of authorities having jurisdiction.
 - C. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.
 - D. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
 - E. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 EXISTING UTILITIES

- A. The gravity sanitary sewer and piping shall remain in service for the duration of the project. Removal and disposal of existing utilities serving the existing treatment facility shall not be removed until approval is given by the Engineer.
- B. Owner will arrange for disconnecting and sealing indicated utilities that serve existing structures before site clearing, when requested by Contractor.
 - 1. Verify that utilities have been disconnected and capped before proceeding with site clearing.
- C. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place as indicated on the construction drawings.

- 1. Arrange with utility companies and/or Owner to shut off indicated utilities.
- D. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify Engineer and Owner not less than two days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Engineer's written permission.
- E. Excavate for and remove underground utilities indicated to be removed. Unless indicated on the drawings, all removed underground utilities shall be disposed of in a lawful manner at no additional cost to the Owner.

3.4 CLEARING AND GRUBBING

- A. CONTRACTOR shall remove all trees, stumps, roots, shrubs, brush, tall grass, vegetation and other debris as may be required for the proper conduct and execution of the work. All work shall be performed in a safe and prudent manner. Removal and subsequent disposal of all material shall be the complete responsibility of the CONTRACTOR. Removal means all parts of the tree or brush, including the portion of the stump within 24 inches of the ground surface. Except in areas to be excavated, stump holes and other holes from which obstructions are removed shall be backfilled with suitable material and compacted.
- B. Disposal of all material resulting from clearing and grubbing shall be the complete responsibility of the CONTRACTOR at no additional cost to the OWNER.

3.5 TOPSOIL STRIPPING

- A. Remove sod and grass before stripping topsoil.
- B. Strip topsoil to depth of 6 inches in a manner to prevent intermingling with underlying subsoil or other waste materials.
 - 1. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects more than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.
- C. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.
 - 1. Limit height of topsoil stockpiles to 72 inches.
 - 2. Do not stockpile topsoil within protection zones.
 - 3. Dispose of surplus topsoil. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused.
 - 4. Stockpile surplus topsoil to allow for respreading deeper topsoil.

3.6 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.
- B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.
 - 1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
 - 2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

3.7 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them.
- B. Disposal of all material resulting from clearing and grubbing shall be the complete responsibility of the CONTRACTOR at no additional cost to the OWNER.

- END OF SECTION -

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Preparing subgrades for slabs-on-grade, walks, turf grasses and plants.
 - 2. Excavating and backfilling for buildings and structures.
 - 3. Drainage course for concrete slabs-on-grade.
 - 4. Subbase course for concrete walks pavements.
 - 5. Subbase course and base course for asphalt paving.
 - 6. Subsurface drainage backfill for walls and trenches.
 - 7. Excavating and backfilling trenches for utilities and pits for buried utility structures.
- B. Related Sections:
 - 1. Section 033000 "Cast-in-Place Concrete" for granular course if placed over vapor retarder and beneath the slab-on-grade.
 - 2. Section 311000 "Site Clearing" for site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.
 - 3. Section 315000 "Excavation Support and Protection" for shoring, bracing, and sheet piling of excavations.

1.3 DEFINITIONS

- A. Backfill: Soil material or controlled low-strength material used to fill an excavation.
 - 1. Backfill material obtained from trenches or on on-site excavations free of cinders, ash, refuse, organic or frozen material, boulders, or other deleterious materials.
- 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: 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 changes in the Work.
 - 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. Structural Fill: Soil materials used to raise existing grades or replace less suitable material.
- H. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 10 cy for bulk excavation or 5 cy 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. Excavation of Footings, Trenches, and Pits: Late-model, track-mounted hydraulic excavator; equipped with a 42-inch- wide, maximum, 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; measured according to SAE J-1179.
- I. 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.
- J. 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.
- K. 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.
- L. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Preexcavation 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.

1.5 PROJECT 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.
 - 3. Do not proceed with work on adjoining property until directed by Engineer.
- B. Utility Locator Service: Notify utility locator service for area where Project is located before beginning earth moving operations.
- C. Do not commence earth moving operations until temporary erosion- and sedimentation-control measures, specified in Section 311000 "Site Clearing," are in place.
- D. The following practices are prohibited within protection zones:
 - 1. Erection of sheds or structures.
 - 2. Impoundment of water.
 - 3. Excavation or other digging unless otherwise indicated.
 - 4. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.
- E. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

1.6 CONSTRUCTION CONSIDERATIONS

- A. GENERAL
 - 1. The CONTRACTOR is solely responsible for designing and constructing stable, temporary excavations and should shore, slope or bench the sides of the excavations as required to maintain stability of both the excavation sides and bottom. All excavations should comply with applicable local, state, and federal safety regulations including the current OSHA Excavation and Trench Safety Standards. Construction site safety generally is the sole responsibility of the CONTRACTOR, who shall also be solely responsible for the means, methods, and sequencing of construction operations. Under no circumstances should the information provided below be interpreted to mean that ENGINEER or OWNER is assuming responsibility for construction site safety or the CONTRACTOR's activities; such responsibility is not being implied and should not be inferred.
- B. EXCAVATION AND SLOPES
 - In no case should slope height, slope inclination, or excavation depth, including utility trench excavation depth, exceed those specified in local, state, and federal safety regulations. Specifically, the current OSHA Health and Safety Standards for Excavations, 29 CFR Part 1926 should be followed. It is the ENGINEER's understanding that these regulations are being strictly enforced and if they are not closely followed, the CONTRACTOR could be liable for substantial penalties.
 - 2. The CONTRACTOR'S "competent person", as defined in 29 CFR Part 1926, shall evaluate the soil exposed in the excavations as part of the

EARTH MOVING ISSUED FOR CONSTRUCTION PAGE 312000 - 3 MARCH 2018 CONTRACTOR'S safety procedures. If an excavation, including a trench, is more than 20 feet deep, it will be necessary to have the side slopes designed by a professional engineer registered in Montana.

3. The CONTRACTOR shall provide the name of their "competent person". The CONTRACTOR's "competent person" shall establish a minimum lateral distance (two feet or greater) from the crest of the slope for all vehicles and spoil piles. Likewise, the CONTRACTOR'S "competent person" should establish protective measures for exposed slope faces.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. Native Soils: In situ or excavated material for use in backfill and embankment construction moisture conditioned and compacted as required for area of use.
- B. 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.
- C. Base Course:
 - 1. Aggregate material shall be furnished by the CONTRACTOR and the gradation of the crushed material shall meet the requirements of the gradations given in the following tables, when tested in accordance with ASTM C117 and C136.

Sieve No. or Size	Percent Passing by dry weight	
3/1"	100	
No. 4	40 - 70	
No. 10	25 - 55	
No. 200	2 – 12	

3/4-inch Minus Surface Course

Sieve No. or Size	Percent Passing by dry weight
1½"	100
1"	90 - 100
1/2"	60 – 85
No. 4	45 – 65
No. 8	33 – 53
No. 200	3 – 12

3.1 PREPARATION

- A. All construction zones shall be cleared and grubbed of all stumps, logs, trees, roots, brush, weeds, tree trimmings, and other vegetation or debris in accordance with Section 311000 Site Clearing.
- B. Protect structures, utilities, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.
- C. Signs, poles, posts, and similar items to be temporarily removed and replaced are to be protected from damage during removal and replacement. Items damaged by the CONTRACTOR shall be replaced at the CONTRACTOR's expense.
- D. Protect and maintain erosion and sedimentation controls during earth moving operations.
- E. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.
- 3.2 BARRICADES, GUARDS AND SAFETY PROVISIONS:
 - A. All excavation, trenching, shoring, and the like, under this contract shall be performed in a manner that meets with the Occupational Safety and Health Standards, 24 CFR Part 1926 Excavations, as published by the Occupational Safety and Health Administration. The CONTRACTOR shall be responsible for enforcing safety and maintaining safe working conditions in the trenching operation.
 - B. To protect persons from injury and to avoid property damage, adequate barricades, construction signs, warning lights, and guards, as required, shall be placed and maintained during the progress of the construction work and until it is safe to resume use of the trench area. Rules and regulations of the local authorities respecting safety provisions shall be observed.
- 3.3 EXPLOSIVES
 - A. Explosives: Do not use explosives.
- 3.4 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. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:

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- a. 24 inches outside of concrete forms other than at footings.
- b. 12 inches outside of concrete forms at footings.
- c. 12 inches beneath bottom of concrete slabs-on-grade.
- d. 6 inches beneath pipe in trenches, and the greater of 24 inches wider than pipe or 42 inches wide.

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 12 inches higher than top of pipe or conduit unless otherwise indicated.
 - 1. Minimum Width of Trench: The minimum width of the trench shall be such as to provide adequate room for workers to install and join the pipe and place and compact the bedding and backfill materials in the specified manner, and not less than the outside diameter (OD) of the pipe plus two feet.
 - 2. Should the CONTRACTOR excavate a trench wider than stated above, he shall at his own expense, provide pipe bedding as defined in Part 2 of this section or take such other measures as the ENGINEER may direct to protect the pipe against the crushing forces of trench backfill. This specification requirement will be strictly enforced. Thus, if the CONTRACTOR plans to use excavating and traveling shield equipment which requires a wider trench than the minimum width/depth relationships specified above, he shall bid the job to use not less than enough "Imported Bedding Material" as required to install the pipe as shown on the Construction Drawings, absorbing the cost of providing and placing this material in either his trench excavation or pipe laying prices.
- 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. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.
 - 2. The CONTRACTOR shall excavate as necessary at the locations shown on the drawings, staked in the field, or otherwise directed by the ENGINEER.
 - 3. The CONTRACTOR shall take precautions to protect all adjoining private and public property and facilities, including underground and overhead utilities, curbs,

sidewalks, driveways, structures, and fences. Any disturbed or damaged facilities will be suitably restored or replaced at no cost to the OWNER.

- 4. Trenches parallel to curb and gutter, sidewalk, walls, or other structures that can be disturbed by the trenching activity, shall normally be no closer than 5 feet to the structure. Special care must be made to protect these structures.
- 5. Excavation shall be by open cut. Concrete and asphalt shall be saw cut in a straight line to make a neat joint with no broken corners or ragged edges, and then replaced according to these specifications. If excavation must take place near a structure, lean concrete shall be used as backfill to fully support the structure. After installing pipe and backfilling as specified, other repairs (if needed) shall be made to the ENGINEER's satisfaction.
- 6. In fields, rights-of-way, grassy areas or other areas where topsoil is present, the CONTRACTOR shall strip the topsoil to a depth indicated by the ENGINEER, usually 12 inches. The topsoil shall be stockpiled and placed back over the trench after backfilling to restore the area to its pre-existing conditions.
- 7. During excavation, materials suitable for backfilling shall be piled in an orderly manner a distance of at least two feet from the banks of the trench to avoid overloading and to prevent slides or cave-ins. Excavated material shall be stockpiled to permit access to existing buildings, hydrants, valves, manholes and other appurtenances. Surface drainage of adjoining areas shall be unobstructed.
- 8. Grading shall be done as may be necessary to prevent surface water from flowing into excavations, and any water accumulating therein shall be promptly removed. Under no circumstances shall water be permitted to rise in trenches until after the pipe has been placed, bedded and backfilled. Any pipe having its alignment or grade changed by floating in a flooded trench shall be re-laid at no additional cost to the OWNER.

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, concrete pads, and pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons, or similar, 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 and areas of excessive pumping or rutting, as determined by Engineer, and replace with structural fill as directed.
- D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.

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 with structural backfill placed and compacted per this specification.
 - 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 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 and 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. Bedding Placement
 - 1. All Bedding Material shall be placed into the trench to a maximum depth of 6 inches at any point after leveling, except bell holes shall have a depth of 3 to 4 inches. The use of bell holes and the placement of bedding shall provide for the full support of the pipe. When deposited in the trench, Bedding Material shall be spread, graded, and initially compacted no more than necessary to insure a

slightly yielding, uniform and continuous support for installed pipe at all points between pipe joints.

2. All Bedding Material above the bottom of the pipe shall be placed to fill any voids adjacent to the pipe, leveled, and thoroughly compacted by tamping, vibration, rodding, or by a combination of these methods. Special effort is required to compact the material under the pipe "haunches" to provide adequate support to the pipe. Placement techniques are to avoid damage to the pipe, coating on pipe and fittings, joint bonds, and corrosion protection materials. Bedding adjacent to and over the pipe is to be placed in layers not to exceed 6 inches, with each layer thoroughly compacted. Bedding adjacent to the pipe is to be placed and compacted on both sides simultaneously. Water settling of bedding is not allowed. All backfill material, equipment used, and the results obtained in placing fill material shall be subjected at all times to the approval of the pipe manufacturer and the ENGINEER.

D. BACKFILL ABOVE BEDDING MATERIAL

- 1. After placing Bedding Material as specified above, the remainder of the backfill in the zone designated "Backfill Above Bedding" shown on the Construction Drawings shall be placed as herein specified, in lifts not to exceed 8 inches (compacted thickness). In this zone, backfill may be placed by machine or other method or combination of methods approved by the ENGINEER, which will not impose excessive, concentrated, or unbalanced loads, thus transmitting a shock or impact to the embedded pipe which might result in damage to, or displacement of the pipe. Frozen material, snow or mud shall not be used in backfill.
- 2. Backfill compaction up to the bottom of the road surface of surface restoration section or up to grade for unsurfaced sections shall be compacted to not less than the following percentages of maximum density, as determined by ASTM D698.
 - Asphalt pavement ninety-five percent (95%);
 - Portland cement concrete surface ninety-five percent (95%);
 - Gravel surface ninety-five percent (95%);
 - Unsurfaced areas ninety percent (90%).
- 3. For backfill which shall be compacted or consolidated to a density equal to or greater than ninety percent (90%), the material shall be placed in continuous horizontal layers not to exceed the uncompacted depth of 12 inches. The CONTRACTOR shall add water or aerate material as required in placing compacted backfill to bring the material within 3% optimum moisture content. In locations where 95% compaction is specified and the excavated soil materials possess natural moisture in excess of 6% above optimum moisture as determined by ASTM D698, the material will be considered unsuitable for backfill. Either the CONTRACTOR or ENGINEER may perform the field tests to determine the in situ moisture content. When the ENGINEER determines the excavated material is unsuitable, it shall be processed by the CONTRACTOR to reduce the moisture content to an acceptable level or removed and disposed of at location of the borrow source, or at locations secured by the CONTRACTOR and approved by the ENGINEER. If the moisture content is between 3 and 6% over optimum, the CONTRACTOR shall blend or aerate the material to reduce it to less than 3% over.

- 4. CONTRACTOR will be responsible for all costs of excavation, haul, placement and compaction of the replacement material from a CONTRACTOR secured source.
- 5. If the CONTRACTOR performs winter construction, frozen material or material containing frozen chunks, mud or snow, must be replaced at the CONTRACTOR's cost.
- 6. Where surface restoration is not specified, the CONTRACTOR shall grade all backfill surfaces and shall maintain them during the period of this contract in such a manner as to provide safe travel by the public, free of settlement, mud holes, ruts and high centers at no additional cost to the OWNER.
- 7. The CONTRACTOR may substitute lean concrete (flowable fill) in areas under streets and roads at his cost if allowed by the ENGINEER, and shall utilize lean concrete if required by the drawings.
- 8. Backfill around hydrants, valve boxes, manholes, inlet boxes or similar appurtenances shall be hand compacted.
- E. Backfill voids with soil while removing shoring and bracing.
- F. Controlled Low-Strength Material: Place final backfill of controlled low-strength material to final subgrade elevation. See Section 3.21 for requirements
- G. 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 appropriately conditioned native soil material.
 - 2. Under walks and pavements, use appropriately conditioned native soil material.
 - 3. Under steps and ramps, use engineered/structural fill.
 - 4. Under building slabs, use engineered/structural fill.
 - 5. Under footings and foundations, use engineered/structural 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.

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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.
 - 1. Heavy compaction equipment shall not be operated within 4-feet of concrete walls.
- 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 95 percent.
- D. Backfill material to be "benched" into existing embankments or berms. Benches to extend into the existing slope a minimum of 24-inches to provide secure bonding of the new embankment fill to the existing slope.
- E. Reconditioning Compacted Areas: Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, re-shape, and compact to required density prior to further construction.

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 required elevations within the following tolerances:
 - 1. Turf or Unpaved Areas: Plus or minus 1 inch.
 - 2. Walks: Plus or minus ½ 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.
- D. Grading Surface of Fill Under Building Slabs: Grade smooth and even, free of voids, compacted as specified, and to required elevation. Provide final grades within a tolerance of ½-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. Where indicated, 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 crossslope 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 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 SURFACE RESTORATION:

A. GRAVEL ROADWAYS OR PARKING AREAS

1. Restore to pre-existing condition or better, but not less than 6 inches of ³/₄" minus crushed base course.

B. WATER POLLUTION CONTROL

1. Water pollution from disturbed areas is to be controlled. Measures used are to comply with appropriate local, state and federal regulations.

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 EXCESS EXCAVATED MATERIAL:

- A. Except as otherwise permitted, all excess excavated materials shall be disposed of away from the site of the work. Broken concrete, asphalt and other coarse debris resulting from pavement or sidewalk removal; excavated rock in excess of the amount permitted to be and actually installed in trench backfill; junk and debris encountered in excavation work; and other similar waste materials shall be legally disposed of away from the site of the work at the CONTRACTOR's expense. In some cases excess material must be placed on the property of the landowner where it came from (see drawings). Excess material may be taken to a landfill.
- B. Excess excavated material not stockpiled as requested by the property owner, shall be disposed of by the CONTRACTOR at his own expense, except as discussed below. The OWNER reserves the right to claim any excess material. The CONTRACTOR shall load the OWNER's trucks. If required by the project Special Provisions or Project Manual, the CONTRACTOR shall haul excess material to a location designated by the OWNER.
- C. Excess earth from excavations located in open fields and unimproved property may be distributed directly back over the pipe trench and within the pipeline easement (below the topsoil) to a maximum depth of 6 inches above the original ground surface elevation, at and across the trench, and sloping uniformly each way therefrom. Material thus placed shall be carefully finished with a drag, blade machine, or other suitable tools, to a smooth, uniform surface without obstructing drainage at any point. This practice shall not be used if the slight mounding interferes with irrigation practices.

EARTH MOVING ISSUED FOR CONSTRUCTION PAGE 312000 - 13 MARCH 2018 Wasting of excess excavated material in the above manner also will not be permitted where the line of trench crosses public road rights-of-way or is within said rights-of-way, and more or less parallels the centerline thereof.

D. No payment will be made separately or directly for haul on any part of the work. All hauling will be considered a necessary and incidental part of the work, and its cost shall be considered by the CONTRACTOR and included in the contract unit price for the pay items of work involved.

- END OF SECTION -
SECTION 315000 - EXCAVATION SUPPORT AND PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes temporary excavation support and protection systems.
- B. Related Sections:
 - 1. Section 011000 "Summary of Work" for temporary utilities and support facilities.

1.3 PERFORMANCE REQUIREMENTS

- A. Design, furnish, install, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting soil and hydrostatic pressure and superimposed and construction loads.
 - 1. Delegated Design: Design excavation support and protection system, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
 - 2. Prevent surface water from entering excavations by grading, dikes, or other means.
 - 3. Install excavation support and protection systems without damaging existing buildings, structures, and site improvements adjacent to excavation.
 - 4. Monitor vibrations, settlements, and movements.

1.4 ACTION SUBMITTALS

A. Delegated-Design Submittal: For excavation support and protection system indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

- A. Other Informational Submittals:
- 1. Photographs or Videotape: Show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by the EXCAVATION SUPPORT AND PROTECTION PAGE 315000 - 1

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absence of, the installation of, or the performance of excavation support and protection systems. Submit before Work begins.

- 2. Record Drawings: Identifying and locating capped utilities and other subsurface structural, electrical, or mechanical conditions.
 - a. Note locations and capping depth of wells and well points.

1.6 PROJECT CONDITIONS

- A. Interruption of Existing Utilities: Do not interrupt any utility serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:
 - 1. Notify Engineer no fewer than two days in advance of proposed interruption of utility.
 - 2. Do not proceed with interruption of utility without Engineer's written permission.
- B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from the data.
 - 1. Make additional test borings and conduct other exploratory operations necessary for excavation support and protection.
 - 2. The geotechnical report is referenced elsewhere in the Project Manual.
- C. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.
 - 1. During installation of excavation support and protection systems, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify Engineer if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Provide materials that are either new or in serviceable condition which will is suitable for shoring and/or bracing the imposed load.

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 that could develop during excavation support and protection system operations.
 - 1. Shore, support, and protect utilities encountered.
- B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
- C. Locate excavation support and protection systems clear of permanent construction so that forming and finishing of concrete surfaces are not impeded.
- D. Monitor excavation support and protection systems daily during excavation progress and for as long as excavation remains open. Promptly correct bulges, breakage, or other evidence of movement to ensure that excavation support and protection systems remain stable.
- E. Promptly repair damages to adjacent facilities caused by installing excavation support and protection systems.

3.2 BRACING

- A. Bracing: Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.
 - 1. Do not place bracing where it will be cast into or included in permanent concrete work unless otherwise approved by Engineer.
 - 2. Install internal bracing, if required, to prevent spreading or distortion of braced frames.
 - 3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.3 REMOVAL AND REPAIRS

A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and bear soil and hydrostatic pressures. Remove in

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stages to avoid disturbing underlying soils or damaging structures, pavements, facilities, and utilities.

- 1. Remove excavation support and protection systems to a minimum depth of 96 inches below overlaying construction and abandon remainder.
- 2. Fill voids immediately with approved backfill compacted to density specified in Section 312000 "Earth Moving."
- 3. Repair or replace, as approved by Engineer, adjacent work damaged or displaced by removing excavation support and protection systems.

END OF SECTION 315000

PART 1 -- GENERAL

1.1 DESCRIPTION

- A. Scope: CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified, and required to install and test all exposed piping, fittings, and specials. The Work includes the following:
 - 1. All types and sizes of exposed piping, except where exposed piping installations are specified under other Sections.
 - 2. Unless otherwise shown or specified, this Section includes all piping beginning at the outside face of structures or structure foundations and extending into the structure. Piping embedded in concrete within a structure or foundation shall be considered as exposed and is included herein. Piping that is permanently or intermittently submerged, or installed in sub-aqueous environments, is considered as exposed and is included in this Section.
 - 3. Work on or affecting existing exposed piping.
 - 4. Installation of all jointing and gasket materials, specials, flexible couplings, mechanical couplings, harnessed and flanged adapters, sleeves, tie rods, and all Work required for a complete exposed piping installation.
 - 5. Supports, restraints, and other anchors.
 - 6. Field quality control, including testing.
 - 7. Cleaning and disinfecting.
 - 8. Incorporation of valves, meters, and special items shown or specified into the piping systems per the Contract Documents and as required
- B. Related Sections:
 - 1. Section 400509 Wall Pipes, Floor Pipes, and Pipe Sleeves
 - 2. Section 400531 Polyvinyl Chloride Process Pipe
 - 3. Section 400553 Process Valves
- C. Coordination:
 - 1. Review installation procedures under this and other Sections and coordinate installation of items that must be installed with or before exposed piping Work.

1.2 REFERENCES

- A. Standards referenced in this Section are:
 - 1. ANSI B16.1, Cast Iron Pipe Flanges and Flanged Fittings

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- 2. ASME Boiler and Pressure Vessel Code.
- 3. ASME B31.3, Process Piping.
- 4. AWS D1.1/D1.1M, Structural Welding Code-Steel.
- 5. ANSI/AWWA 0111, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- 6. ANSI/AWWA C206, Field Welding of Steel Water Pipe.
- 7. ANSI/AWWA C600, Installation of Ductile Iron Water Mains and Their Appurtenances.
- 8. ANSI/AWWA C606, Grooved and Shouldered Joints.
- 9. ANSI/AWWA C651, Disinfecting Water Mains.
- 10. AWWA M11, Steel Pipe A Guide for Design and Installation.
- 11. AWWA M23, PVC Piping Design and Installation.
- 12. AWWA M41, Ductile-Iron Pipe and Fittings.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Comply with requirements and recommendations of authorities having jurisdiction over the Work.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Detailed drawings in plan and, as applicable, section.
 - b. Details of piping, valves, supports, accessories, specials, joints, harnessing, and main anchor supports, and connections to existing piping, structures, equipment, and appurtenances.
 - 2. Testing Plans, Procedures, and Testing Limitations
 - a. Submit description of proposed testing methods, procedures, and apparatus, and obtain ENGINEER's approval prior to testing.
 - 3. Informational Submittals: Submit the following:
 - a. Certificates:
 - i. Submit a certificate, signed by manufacturer of each product, certifying that product complies with applicable referenced standards.
 - ii. Welder's certificate in compliance with Paragraph 3.1.E.7.c of this Section.
- B. Closeout Submittals: Submit the following:

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- 1. Record Documentation:
 - a. Maintain accurate and up-to-date record documents showing field and Shop Drawing modifications. Record documents for exposed piping Work shall show actual location of all piping and appurtenances on a copy of the Drawings, unless otherwise approved by ENGINEER.
 - b. Record documents shall show piping with elevations referenced to the project datum and dimensions from permanent structures. For straight runs of pipe provide offset dimensions as required to document pipe location.
 - c. Include section drawings with exposed piping record documents when the Contract Documents include section Drawings.
- 1.5 DELIVERY, STORAGE AND HANDLING
 - A. Delivery:
 - 1. Deliver products to Site to ensure uninterrupted progress of the Work.
 - 2. Upon delivery, inspect pipe and appurtenances for cracked, gouged, chipped, dented, and other damage and immediately remove damaged products from Site.
 - B. Storage:
 - 1. Store products for convenient access for inspection and identification. Store products off the ground using pallets, platforms, or other supports. Protect packaged products from corrosion and deterioration.
 - 2. Pipe and fittings other than thermoplastic materials may be stored outdoors without cover. Thermoplastic pipe and fittings stored outdoors shall be covered.
 - C. Handling:
 - 1. Handle pipe, fittings, specials, and accessories carefully with approved handling devices. Do not drop or roll material of delivery vehicles. Do not otherwise drop, roll, or skid piping.
 - 2. Avoid unnecessary handling of pipe.
 - 3. Keep pipe interiors free of dirt and foreign matter.
 - 4. Protect interior linings and exterior coatings of pipe and fittings from damage. Replace pipe and fittings with damaged lining regardless of cause of damage. Repair damaged coatings.

PART 2 -- PRODUCTS

- 2.1 MATERIALS
 - A. Piping materials are specified in the Exposed Piping Schedule at the end of this Section. Piping materials shall conform to Specification for each type of pipe and piping appurtenances in applicable sections of Division 40, Process Interconnections.

- B. Markings and Identification:
 - 1. Pipe Markings:
 - a. Clearly mark each piece of pipe or fitting with a designation conforming to that shown on the approved Shop Drawings.
 - b. Manufacturer shall cast or paint on each length of pipe and each fitting the pipe material, diameter, and pressure or thickness class.

PART 3 -- PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine conditions under which the Work is to be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.
- B. INSTALLATION
 - 1. General:
 - 2. Install piping as shown, specified and as recommended by the pipe and fittings manufacturer.
 - 3. If there is a conflict between manufacturer's recommendations and the Contract Documents, request in writing instructions from ENGINEER before proceeding.
 - 4. Provide pipe manufacturer's installation specialist at Site as specified on this Section.
- C. Temporary Blind Flanges, Plugs, Caps, and Bulkheads:
 - 1. Temporarily plug installed pipe at the end of each day of work or other interruption of pipe installation to prevent entry of animals, liquids, and persons into pipe, and entrance or insertion of deleterious materials into pipe.
 - 2. Install standard plugs in all bells at dead ends, tees, and crosses. Cap all spigot and plain ends.
 - 3. Fully secure and block blind flanges, plugs, caps, and bulkheads installed for testing, designed to withstand specified test pressure.
 - 4. Where plugging is required for phasing of Work or subsequent connection of piping, install watertight, permanent type blind flanges, plugs, caps, or bulkhead acceptable to ENGINEER.
- D. Piping Installation:
 - 1. Conform to manufacturer's instructions and requirements of standards and manuals listed in this Section, as applicable:
 - a. Ductile Iron Pipe: ANSI/AWWA 0600, AWWA M41.
 - b. Steel Pipe: ASME B31.3, ANSI/AWWA C206, AWWA M11.

- c. Thermoplastic Pipe: AWWA M23
- 2. Install straight runs true to line and elevation.
- 3. Install vertical pipe truly plumb in all directions.
- 4. Install piping parallel or perpendicular to walls of structures. Piping at angles and 45 degree runs across corners of structures will not be accepted unless specifically shown on the Contract Documents or approved by the ENGINEER.
- 5. Install small diameter piping generally as shown when specific locations and elevations are not indicated. Locate such piping as required to avoid ducts, equipment, beams, and other obstructions.
- 6. Install piping to leave all corridors, walkways, work areas, and similar spaces unobstructed. Unless otherwise approved by ENGINEER provide a minimum headroom clearance under piping and pipe supports of 7.5 feet. Clearances beneath piping shall be measured from the outermost edge of piping, flanges or other type of joint that extends beyond the nominal outside diameter of piping.
- 7. Protect and keep clean interiors, fittings, and valves of pipe that will convey potable water, chemicals, and other pipe designated by ENGINEER.
- 8. Cutting: Limit field cutting of pipe. If required, cut pipe from measurements verified at Site. Field cut pipe, only where required, with a machine specially designed for cutting type of pipe being installed. Make cuts carefully without damage to pipe, coating, or lining, and with a smooth end at right angles to axis of pipe. Cut ends of push-on joint type pipe shall be tapered and sharp edges filed off smooth. Do not flame-cut pipe.
- E. Jointing Pipe:
 - 1. General:
 - a. Make joints in accordance with pipe manufacturer's recommendations and Contract Documents.
 - b. Cut piping accurately and squarely and install without forcing or springing.
 - c. Ream out pipes and tubing to full inside diameter after cutting. Remove all sharp edges on end cuts.
 - d. Remove all cuttings and foreign matter from inside of pipe and tubing before installation. Thoroughly clean all pipe, fittings, valves, specials, and accessories before installing.
 - 2. Ductile Iron Mechanical Joint Pipe:
 - a. Wipe clean the socket, plain end and adjacent areas immediately before making joint. Make certain that cut ends are tapered and sharp edges are filed off smooth.
 - b. Lubricate plain end and gasket with soapy water or pipe manufacturer's recommended pipe lubricant, per ANSI/AWWA C111, just prior to slipping gasket onto plain end of joint assembly.

- c. Place gland on plain end with lip extension toward plain end, followed by gasket with narrow edge of gasket toward the plain end.
- d. Insert pipe into socket and press gasket firmly and evenly into gasket recess. Keep joint straight during assembly.
- e. Push gland toward socket and center it around pipe with the gland lip against the gasket.
- f. Insert bolts and hand tighten nuts.
- g. Deflect joint only after assembled when approved by ENGINEER.
- h. Make deflection after joint assembly, if approved by ENGINEER, but prior to tightening bolts. Alternately tighten bolts 180 degrees apart to seat the gasket evenly. Bolt torque shall be:

Pipe Diameter	Bolt Diameter	Range of Torque
(inches)	(inches)	(ft-lbs)
3	5/8	45 to 60
4 to 24	3/4	75 to 90
30 to 36	1	100 to 120
42 to 48	1.25	120 to 150

- 3. Ductile Iron and Steel Flanged Joints:
 - a. Assemble flanged joints using ring-type gaskets, with thickness as recommended by pipe manufacturer but not less than 1/8-inch thick, for raised-face flanges. Use full-face gaskets for flat-face flanges, unless otherwise approved by ENGINEER or recommended by pipe manufacturer. Gaskets shall be suitable for the service intended in accordance with the manufacturer's ratings and instructions. Gaskets shall be properly centered.
 - b. Tighten bolts in a sequence that provides equal distribution of bolt loads.
 - c. Length of bolts shall be uniform. Bolts shall not project beyond the nut more than 1/4-inch or fall short of the nut when fully taken up. Machine-cut ends of bolts to be neatly rounded. Do not use washers.
 - d. Prior to assembly of flanged joints, lubricate bolt threads and gasket faces.
 - e. Alternately tighten bolts 180 degrees apart to compress the gasket evenly.
 - f. After assembly, coat all bolts and nuts, except stainless steel bolts and nuts, with same coating as applied to the pipe and fittings being joined.
- F. Installing Valves and Accessories:
 - 1. Provide supports for large valves, flow meters, and other heavy items as shown or required to prevent strain on adjoining piping.
- G. Unions:
 - 1. Provide a union downstream of each valve with screwed connections.

- 2. Provide screwed or flanged unions at each piece of equipment, where shown, and where necessary to install or dismantle piping.
- H. Transitions from One Type of Pipe to Another:
 - 1. Provide all necessary adapters, specials, and connection pieces required when connecting different types and sizes of pipe or connecting pipe made by different manufacturers.
- I. Closures:
 - 1. Provide closure pieces, such as blind flanges and caps, shown or required to complete the Work.
- 3.2 THRUST RESTRAINT
 - A. General
 - 1. Provide thrust restraint on all pressure piping systems and where otherwise shown or specified.
 - 2. Thrust restraints shall be designed for axial thrust exerted by test pressure specified in the Exposed Piping Schedule at end of this Section.
 - B. Restrained Pipe Joints:
 - 1. Pipe joints shall be restrained by means suitable for the type of pipe being installed.
 - 2. Ductile Iron, Push-on Joints and Mechanical Joints: Restrain with a proprietary restrained joint system. Ductile iron pipe, lugs, and tie rods, or other joint restraint systems approved by ENGINEER. Restrain ductile iron pipe connected by flexible couplings or flanged coupling adapters by harnessing across the coupling or adapter using tie rods or extended bolts connecting between flanges.
 - 3. Steel Pipe Joints: Provide butt-welded joints, lap welded joints, flanged joints, or mechanical coupling connections as shown. Provide tie rods connected to lugs welded to the steel pipe for restraint at mechanical couplings.
 - 4. Thermoplastic, FRP and HDPE Joints: Where bell and spigot-type or other nonrestrained joints are utilized, provide tie rods across the joint or other suitable joint restraint system, subject to approval of ENGINEER.

3.3 WORK AFFECTING EXISTING PIPING

- A. Location of Existing Piping:
 - 1. Locations of existing piping shown on Drawings is approximate.
 - 2. Determine the true location of existing piping to which connections are to be made, crossed, and that could be disturbed, and determine location of other facilities that could be affected by the Work.
- B. Work on Existing Pipelines:

- 1. Cut or tap pipes as shown or required with machines and tools specifically designed for cutting or tapping pipelines.
- 2. Install temporary plugs to prevent entry of mud, dirt, water, and debris into pipe.
- 3. Provide necessary adapters, sleeves, fittings, pipe, and appurtenances required to complete the Work.

3.4 PAINTING

A. Exposed ductile iron and/or steel fittings and pipe paint/coatings shall be prepped and applied per the manufacturer recommendations with special attention given to surface preparation, application conditions, and finished dry film thickness.

3.5 FIELD QUALITY CONTROL

- A. Testing, General:
 - 1. Test all piping, except as exempted in the Exposed Piping Schedule.
 - 2. Notification: Notify ENGINEER at least 48 hours prior to testing.
 - 3. When authorities having jurisdiction are to witness tests, notify ENGINEER and authorities having jurisdiction in writing at least 48 hours in advance of testing.
 - 4. Conduct all tests in presence of ENGINEER.
 - 5. Remove or protect pipeline-mounted devices that could be damaged by testing.
 - 6. Provide all apparatus and services required for testing, including:
 - 7. Test pumps, compressors, hoses, calibrated gages, meters, test containers, valves, fittings, and temporary pumping systems required to maintain OWNER's operations.
 - 8. Temporary bulkheads, bracing, blocking, and thrust restraints.
 - 9. Provide air if an air test is required, power if pumping is required, and gases if gases are required.
 - 10. Unless otherwise specified, OWNER will provide fluid required for hydrostatic testing. CONTRACTOR shall provide means to convey fluid for hydrostatic testing into the pipe being tested. CONTRACTOR shall provide fluid for other types of testing required.
 - 11. Repair observed leaks and repair pipe that fails to meet acceptance criteria. Retest after repair.
 - 12. Unless otherwise specified, testing shall include existing piping systems that connect with new piping system. Test existing pipe to nearest valve. Piping not installed by CONTRACTOR and that fails the test shall be repaired upon authorization of ENGINEER or OWNER. Repair of existing piping will be paid as extra work unless otherwise specified.
 - 13. Test Schedule:
 - a. Refer to the Exposed Piping Schedule for type of test required and required test pressure.

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- b. Unless otherwise specified, the required test pressures are at lowest elevation of pipeline segment being tested.
- c. For piping not listed in Exposed Piping Schedule:
 - i. Hydrostatically test pipe that will convey liquid at a pressure greater than five
 (5) psig. Provide process air pipe test for pipe that will convey air or gas under pressure or vacuum, except chlorine gas, which requires a separate test.
- d. Test Pressure:
 - i. Use test pressures listed in Exposed Piping Schedule.
 - ii. If test pressure is not listed in Exposed Piping Schedule, or if a test is required for piping not listed in the Exposed Piping Schedule, test pressure will be determined by the ENGINEER based on the maximum anticipated sustained operating pressure and the methods described in the applicable ANSI/AWWA manual or standard that applies to the piping system.
- B. Hydrostatic Testing:
 - 1. Pipeline 30-inches diameter and larger shall be visually inspected that all debris has been removed prior to flushing.
 - 2. Prior to hydrostatic testing, pipelines shall be flushed or blown out as appropriate. The CONTRACTOR shall test pipelines in sections. Sections to be tested shall be defined by isolation valves in the pipeline. Where such valves are not present, the CONTRACTOR shall install temporary bulkheads or plugs for the purpose of testing. Sections that have a zero leakage allowance may be tested as a unit.
 - 3. No section of the pipeline shall be tested until field-placed concrete or mortar has attained an age of 14 Days. The test shall be made by closing valves when available or by placing bulkheads and filling the line slowly with water. The CONTRACTOR shall be responsible for ascertaining that test bulkheads are suitably restrained to resist the thrust of the test pressure without damage to or movement of the adjacent pipe. Unharnessed sleeve-type couplings, expansion joints, or other sliding joints shall be restrained or suitably anchored prior to the test to avoid movement and damage to piping and equipment. Remove or protect any pipeline-mounted devices that may be damaged by the test pressure.
 - 4. The CONTRACTOR shall provide sufficient temporary taps in the pipelines to allow for trapped air to exit. After completion of the tests, such taps shall be permanently plugged. Care shall be taken that air relief valves are open during filling.
 - 5. The pipeline shall be filled at a rate which will not cause any surges or exceed the rate at which the air can be released through the release valves at a reasonable velocity. The air within the pipeline shall be allowed to escape completely. The differential pressure across the orifices in the air release valves shall not be allowed to exceed 5 psi at any time during filling. After the pipeline or section thereof has been filled, it shall be allowed to stand under a slight pressure for at least 24 hours to allow the concrete or mortar lining, as applicable, to absorb water and to allow the escape of air from air pockets. During this period, bulkheads, valves, and connections shall be examined for leaks. If leaks are found, corrective measures satisfactory to the ENGINEER shall be taken.

- 6. Timed test period shall not begin until after the pipe has been filled, exposed to the required wetting period, air has been expelled, and pressure stabilized.
- 7. The hydrostatic test shall consist of holding the indicated test pressure on the pipeline segment for a period of 2 hours. The test pressure for yard piping shall be as indicated on the Piping Schedule measured at the lowest point of the pipeline section being tested. No pressure test will be required for a reservoir or tank overflow line. Visible leaks that appear during testing shall be repaired in a manner acceptable to the ENGINEER. Add water to restore the test pressure if the pressure decreases 5 psi below test pressure during the test period.
- 8. Pump from a test container to maintain test pressure. Measure volume of fluid pumped from test container and record on test report. Record pressure at test pump at fifteen minute intervals for duration of test.
- 9. The maximum allowable leakage shall be as indicated on the Piping Schedule and the table below. Pipe with welded or soldered joints shall have no leakage. Exposed piping shall show no visible leaks and no pressure loss during the test. In the case of pipelines that fail to pass the leakage test, the CONTRACTOR shall determine the cause of the leakage, shall take corrective measures necessary to repair the leaks, and shall again test the pipeline, repeating as necessary until the pipeline passes.
- 10. Allowable Leakage Rates: Leakage is defined as the quantity of fluid supplied to pipe segment being tested to maintain pressure within five psi of the test pressure during timed test period. Allowable leakage rates for piping are:

Pipe and Joint Type (See Note 3)	Test Standard	Test Pressure	Test Duration	Allowed Leakage
Ductile iron, all joint types	AWWA C600 AWWA Manual M41	150 percent of working pressure; See Note 1	2 hours	See Equation A
PVC	AWWA C605	125 percent of working pressure	2 hours	See Equation A
Welded Steel Pipe	AWWA Manual M11	125 percent of working pressure	2 hours min.	Zero

Pipe Test Parameters

Note 1: 150 percent of working pressure, but also satisfy these conditions:

- no less pressure than 125 percent of working pressure at the highest point in the test reach
- do not exceed any pipe, fitting, or thrust restraint design pressure no more pressure than 200 percent of rated pressure of metal seated valves or hydrants

- no more than rated pressure of resilient seated gate or butterfly valves
- pressure during test must not vary more than 5 psi

Equation A:	= (SD/148,000)P ^{1/2}
-------------	--------------------------------

Where

:	L =	leakage, gallons per hour
	S =	length tested or maximum test length allowed,
		whichever is smaller, feet
	D =	pipe diameter, inches

- P = test pressure, psi
- 11. When testing against closed, metal-seated valves, an additional leakage per closed valve of 0.0078 gallons per hour per inch of nominal valve size is allowed.
- 12. Rates based on formula or table in AWWA Manual M41:
 - Metal and fiberglass pipe joined with rubber gaskets as sealing members, including a. the following joint types:
 - i. Bell and spigot and push-on joints.
 - ii. Mechanical joints.
 - iii. Bolted sleeve type couplings.
 - iv. Grooved and shouldered couplings.
- C. Examination of Welds:
 - 1. Personnel performing examination of welds shall be gualified to at least Level II, in accordance with ASNT SNT-TC-1A.
 - 2. Conform to ASME Boiler and Pressure Vessel Code Section V and applicable articles for examination of welds.
 - 3. Visually examine all welds, Category D Fluid Service, in conformance with ASME 831.3.
 - 4. Examine at least ten percent of welds using liquid penetrant examination.
 - 5. If a defect is detected, all welds shall be examined by liquid penetrant examination.
 - 6. At conclusion of liquid penetrant examination, remove penetrant test materials by flushing, washing, or wiping clean with applicable solvents.

CLEANING AND DISINFECTION 3.6

- A. General: Clean pipe systems as follows:
 - Thoroughly clean all piping, including flushing with water, dry air, or inert gas as 1. required, in a manner approved by ENGINEER, prior to placing in service. Flush chlorine solution and sodium hypochlorite piping with water.

2. For piping that requires disinfection and has not been kept clean during storage or installation, swab each section individually before installation with a five percent hypochlorite solution.

END OF SECTION 400505

SECTION 400507 – HANGERS AND SUPPORTS FOR PROCESS PIPING

PART 1 -- GENERAL

1.1 DESCRIPTION

A. SCOPE: The work covered by this section includes furnishing and installation of pipe and equipment hangers, supports, and accessories necessary to complete the work.

1.2 RELATED SECTIONS

- B. Section 400505 Exposed Piping Installation
- C. Section 400509 Wall Pipes, Floor Pipes and Pipe Sleeves
- D. Section 400553 Process Valves
- 1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS
 - A. Manufacturer's Standardization Society (MSS) SP-58 Pipe Hangers and Supports -Materials, Design, Manufacture, Selection, Application and Installation
- 1.4 SUBMITTALS
 - A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Detailed drawings showing all hangers and supports for each piping system specified.
 - 2. Product Data:
 - a. Submit manufacturers' catalogs, literature, and engineering data on all hangers and supports.

PART 2 -- PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Piping systems and pipe connections to equipment shall be properly anchored and supported in order to prevent undue deflection, vibration, and dislocation due to seismic events, line pressures, pipe weight, fluid weight, liquid movement, thermal changes, vibration, probable forces applied during construction, and stresses on piping, equipment, and structures.
- B. Standard and fabricated hangers and supports shall be furnished complete with necessary inserts, bolts, nuts, rods, washers, and other accessories.
- 2.2 SUPPORT LOCATIONS

- A. Where locations are not specifically identified in the drawings, pipe supports shall be placed according to the following guidelines.
 - 1. Generally, run piping in groups where practicable and parallel to building wall. Provide minimum clearance of 1-inch between pipe and other work.
 - 2. Install hangers or supports at all locations where pipe changes direction.
 - 3. All hangers and supports shall be capable of vertical adjustment after placement of piping.
 - 4. Different types of hangers or supports shall be kept to a minimum.
 - 5. All suspended or supported ductile iron pipe shall have a hanger or support adjacent to each hub.
 - 6. Support vertical piping at each floor and between floors by stays or braces to prevent rattling and vibration.
 - 7. Hanger rods shall be straight and vertical. Chain, wire, strap or perforated bar hangers shall not be used. Hangers shall not be suspended from piping.

2.3 SUPPORT SPACING

A. Maximum support spacing unless otherwise shown or approved

	Maximum Pip			
Pipe Size (inches)	Steel	Copper	Plastic ²	Cast/Ductile Iron
3/8 to 3/4	5	6	Cont. ³	-
1	6	6	5	-
1-1/4	6	6	5	-
1-1/2	6	6	5	-
2	10	10	5	-
2-1/2	10	10	5	-
3	10	10	5	
4	12	12	5	12 feet for
6	12	12	5	pressure
8	12	12	5	pipe
10	12	-	5	
12	12	-	10	
14	12	-	-	10 feet for
16	12	-	-	Soil/drainage
18	12	-	-	pipe
20	12	-	-	
24 and larger	12	-	_	

¹Pipe shall not have pockets formed in the span due to sagging of the pipe between supports caused by the weight of the pipe, medium in the pipe, insulation, valves and fittings.

²Span shown is for Schedule 80 CPVC pipe at 100°F. Spans for other plastics, other CPVC pipe Schedules and pipes at higher temperatures shall be shortened in accordance with the pipe manufacturer's recommendations.

³Continuous means pipe shall be in unistrut or similar channel.

2.4 CONCRETE ANCHORS

A. Unless otherwise indicated, concrete anchors for pipe supports shall be according to the following table; consult the ENGINEER for any anchor applications not appearing on the table.

Pipe Support Application	Type of Concrete Anchor
New Concrete	Use embedded concrete insert anchors on a grid pattern. Use Grinnell (Anvil International), Tolco, or equal.
Existing Concrete	Use non-shrink grouted anchors, metallic type expansion anchors, or epoxy anchors. Exceptions: Metallic type expansion anchors and epoxy anchors are not permitted for pipe supports subject to vibrating loads. Epoxy anchors are not permitted where the concrete temperature is in excess of 100 deg F or higher than the limiting temperature recommended by the manufacturer. Epoxy anchors are not accepted where anchors are subject to vibration or fire.
Vibratory Loads and High-Temperature Conditions	Use non-shrink grouted anchors

2.5 HANGERS AND SUPPORTS

- A. Hangers and supports where shown shall be in accordance with detail drawings.
- B. Hangers and supports not shown shall be in accordance with MSS SP 58.
- C. Manufacturers
 - 1. Anvil International
 - 2. TOLCO
 - 3. Pipe Support Group (Bergen)
 - 4. Unistrut Corporation

5. Or equal

2.6 THREADED STEEL RODS:

- A. Two inch vertical adjustment with two nuts each end for positioning and locking.
- B. Size hanger rods according to the schedule below, unless otherwise noted:

Nominal Pipe	Rod Diameter
(Inches)	(Inches)
2 and less	3/8
2-1/2 to 3-1/2	1/ ₂
4	5/8
6	3/4
8 through 12	7/8
14 through 18	1
20 through 30	1-1/4

2.7 COATING & CORROSION PROTECTION

- A. Galvanizing
 - Unless otherwise indicated, fabricated pipe supports other than stainless steel or nonferrous supports shall be blast-cleaned after fabrication and hot-dip galvanized in accordance with ASTM A 123 - Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- B. Stainless Steel
 - 1. Use Type 304 stainless steel supports, rods, anchor bolts and fasteners shall be as indicated in the drawings and inside tanks subject to high humidity, water spray or submergence.
 - a. Stainless steel required inside SBR tanks, post equalization tank and digester tanks.

PART 3 -- PRODUCTS

- 3.1 INSTALLATION
 - A. General
 - 1. Pipe supports, hangers, brackets, anchors, guides, and inserts shall be fabricated and installed in accordance with the manufacturer's printed instructions.

HANGERS AND SUPPORTS FOR PROCESS PIPING ISSUED FOR CONSTRUCTION

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- 2. Concrete inserts for pipe hangers and supports shall be coordinated with the formwork.
- B. Appearance
 - 1. Pipe supports and hangers shall be positioned in order to produce an orderly, neat piping system.
 - 2. Hanger rods shall be vertical, without offsets.
 - 3. Hangers shall be adjusted to line up groups of pipes at the proper grade for drainage and venting, as close to ceilings or roofs as possible, and without interference with other WORK.
- C. Fabrication
 - 1. Quality Control
 - a. Pipe hangers and supports shall be fabricated and installed by experienced welders and fitters, using the best welding procedures available.
 - b. Fabricated supports shall be neat in appearance without sharp corners, burrs, or edges.

- END OF SECTION -

SECTION 400509 – WALL PIPES, FLOOR PIPES AND PIPE SLEEVES

PART 1 -- GENERAL

1.1 DESCRIPTION

- A. SCOPE: The work covered by this section includes furnishing and installation of wall pipes, floor supports, pipe sleeves and associated appurtenances.
- 1.2 RELATED SECTIONS
 - A. Section 033000 Cast-In-Place Concrete
 - B. Section 400505 Exposed Piping Installation
- 1.3 ACTION SUBMITTALS
 - A. Furnish submittals in accordance with Section 013300 Contractor Submittals.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of pipe, from manufacturer.

PART 2 -- PRODUCTS

- 2.1 GENERAL
- 2.2 WALL PENETRATION SEALS:
 - A. Pipe penetrations through existing concrete walls shall be cored drilled with a smooth level surfacing. Core drill holes and pipe penetration shall be sealed watertight with a Link-Seal® Modular Seal or equal as manufactured by PSI / Thunderline / Link-Seal.
 - Modular seal shall utilize EPDM seal elements (black) unless low durometer (blue) is needed for the lower strength pipe (PVC, HDPE, Sch 10 steel). Pressure plates to be reinforced nylon polymer. Bolts and nuts to be 316 stainless steel. Temperature range of seals shall be -40 deg to 250 deg F.

PART 3 -- EXECUTION

- 3.1 GENERAL
 - A. INSTALLATION
 - 1. Wall and Floor Pipes: Install as shown and in accordance with approved Shop Drawings.

- 2. Wall Pipe Seal: Install wall pipe seal in accordance to the manufacturer's recommendations and approved Shop Drawings
 - a. All pipe joints and annular spaces in walls subjected to hydrostatic pressure shall be completely watertight.
 - b. Use link type seals to seal sleeve against hydrostatic pressure. Size core drill hole or sleeves to provide annular space required to suit the link type mechanical seals that are used.

- END OF SECTION -

SECTION 400531 – POLYVINYL CHLORIDE PROCESS PIPE

PART 1 -- GENERAL

- 1.1 DESCRIPTION
- A. Scope: CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified, and required to install and test all thermoplastic pipe and associated fittings.
 - 1. Extent of piping is shown and shall be in accordance with piping schedules in Section 40 05 05, Exposed Piping Installation.
- B. Related Sections:
 - 1. Section 400505 Exposed Piping Installation
 - 2. Section 400507 Hangers and Supports for Process Piping
 - 3. Section 400509 Wall Pipes, Floor Pipes, and Pipe Sleeves
 - 4. Section 400553 Process Valves

1.2 REFERENCES

- A. Standards referenced in this Section are:
 - 1. ASTM D1784, Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
 - 2. ASTM D1785, Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120.
 - 3. ASTM D2466, Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
 - 4. ASTM D2467, Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
 - 5. ASTM D2564, Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
 - 6. ASTM D2665, Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
 - 7. ASTM D3034, Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
 - 8. ASTM D3035, Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.

- 9. ASTM D3139, Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
- 10. ASTM D3212, Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
- 11. ASTM D3261, Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
- 12. ASTM F441/F441M, Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
- 13. ASTM F477, Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
- 14. ASTM F1336, Specification for Poly (Vinyl Chloride) (PVC) Gasketed Sewer Fittings.

1.3 SUBMITTALS

- B. Shop Drawings:
 - 1. Submit piping layout Shop Drawings in accordance with Section 40 05 05, Exposed Piping Installation.
 - 2. Submit product data on pipe, fittings, gaskets, hardware, and appurtenances sufficient to demonstrate compliance with the Contract Documents.
 - 3. Submit manufacturer's certificate of compliance standards referenced in this Section.

PART 2 -- PRODUCTS

- 2.1 SERVICE CONDITIONS
 - A. General:
 - 1. Pipe materials shall be suitable for services intended. Refer to piping schedules in Section 40 05 05, Exposed Piping Installation.
 - 2. Pipe shall be homogeneous throughout and free of visible cracks, holes, foreign inclusions, and other defects. Unless otherwise shown or indicated, pipe shall be uniform in color, opacity, density, and other physical properties.
 - 3. Pipe, fittings, and appurtenances in contact with potable water or water that will be treated to become potable shall be listed in ANSI/NSF 61 as being suitable for contact with potable water, and shall comply with requirements of the authorities having jurisdiction at the Site.
- 2.2 POLYVINYL CHLORIDE (PVC) PIPING
 - A. PVC Pipe General Applications: Unless otherwise shown or indicated, PVC pipe shall comply with the following:

- 1. Manufacturers: Provide products of one of the following:
 - a. Ipex, Inc.
 - b. Spears Manufacturing Company.
 - c. Or equal.
- 2. Material: Unless otherwise specified, comply with the following:
 - a. Type and Grade: Type 1, Grade 1.
- 3. Wall Thickness: Schedule 80 complying with ASTM D1784 and ASTM D1785, and US Product Service PS 21-70 as having same outside diameter dimension as castiron pipe.
- 4. Temperature Rating: Rated for temperature to 140 degrees F.
- 5. Color: Gray.
- B. Fittings: Type, grade, schedule, and color of fitting shall match the associated pipe.
 - 1. Solvent Weld: Comply with ASTM D2467.
 - 2. Threaded: Threaded fittings shall comply with ASTM D2464.
 - 3. Flanged: Provide flanged fittings with Neoprene gaskets.
- C. Joints:
 - 1. Solvent Weld: Use primer and solvent cement recommended by PVC pipe manufacturer for the application. Primer shall be in accordance with ASTM F656, and solvent cement shall be in accordance with ASTM D2564.
 - 2. Threaded: Use 100 percent virgin polytetrafluoroethylene (Teflon or PTFE) tape for threaded fittings. Pipe shall not be threaded.
 - 3. Flanged: Provide with backup flange minimum 1/8-inch thick. Backup flanges and connecting bolts shall be Type 304 stainless steel.

PART 3 -- EXECUTION

3.1 INSPECTION

A. Inspect pipe materials for defects in material and workmanship. Verify compatibility of pipe and fittings.

3.2 INSTALLATION

A. For exposed piping installation, refer to Section 40 05 05, Exposed Piping Installation.

THERMOPLASTIC PIPE ISSUED FOR CONSTRUCTION - END OF SECTION -

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SECTION 400553 – PROCESS VALVES

PART 1 -- GENERAL

1.1 DESCRIPTION

- A. SCOPE: The work covered by this section includes the furnishing and installation of interior valves and appurtenances.
- B. Related Sections:
 - 1. Section 400509 Wall Pipes, Floor Pipes, and Pipe Sleeves
 - 2. Section 400531 Polyvinyl Chloride Process Pipe

PART 2 -- PRODUCTS

2.1 BUTTERFLY VALVES:

- 1. Valve manufacturer shall verify that the valve will be fully operational (full open) as installed per the project drawings and compatible with the I.D. of schedule 80 PVC Pipe.
- 2. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. DeZURIK/Copes-Vulcan; a unit of SPX Corporation.
 - b. Milliken Valve Company.
 - c. Mosser Valve; a division of Olson Technologies, Inc.
 - d. Mueller Co.; Water Products Div.
 - e. Pratt, Henry Company.
 - f. Val-Matic Valve & Manufacturing Corp.
- 3. Description: Rubber seated.
 - a. Standard: AWWA C504.
 - b. Body: Cast or ductile iron.
 - c. Body Type: Wafer
 - d. Pressure Rating: 150 psig.
 - e. Epoxy coated suitable for submerged conditions.
- 4. Actuator: Manual actuators shall be provided on all hand operated valves. Handwheel actuators with extension stems shall be provided, as shown on the construction drawings. The direction of opening shall be counterclockwise, and the word "OPEN" shall, in 1/2 inch or larger letters, be cast on the operator to clearly indicate the direction to turn the operator when opening the valve.

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PART 3 -- EXECUTION

3.1 INSPECTION

- A. Examine conditions under which materials and equipment are to be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.
- 3.2 INSTALLATION
 - A. Install valves and appurtenances in accordance with:
 - 1. Supplier's instructions and the Contract Documents.
 - B. Orientation
 - 1. Install horizontally-oriented plug valves with shaft in horizontal position.
 - 2. Install rubber seated ball valves with shaft in horizontal position.
 - C. Install valves plumb and level. Install all valves to be free from distortion and strain caused by misaligned piping, equipment, and other causes.
 - D. Exposed Valves:
 - 1. Provide supports for large or heavy valves and appurtenances as shown or required to prevent strain on adjoining piping.
 - 2. Operators:
 - a. Install valves so that operating handwheels or levers can be conveniently turned from operating floor without interfering with access to other valves, piping, structure, and equipment, and as approved by ENGINEER.
 - b. Avoid placing operators at angles to floors or walls.
 - c. Orient chain operators out of way of walking areas.
 - E. Install valves so that indicator arrows are visible from floor level.
 - F. Floor Stands and Stems:
 - 1. Install floor stands as shown and as recommended by manufacturer.
 - 2. Provide lateral restraints for extension bonnets and extension stems as shown and as recommended by manufacturer.
 - 3. Provide sleeves where operating stems pass through floor. Extend sleeves two inches above floor.

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3.3 FIELD QUALITY CONTROL

A. Field Tests:

- 1. Adjust all parts and components as required to provide correct operation of valves.
- 2. Conduct functional field test on each valve in presence of ENGINEER to demonstrate that each valve operates correctly.
- 3. Demonstrate satisfactory opening and closing of valves at specified criteria requiring not more than 40 pounds effort on manual actuators.

- END OF SECTION -

SECTION 407300 - METERS

PART 1 -- GENERAL

1.1 DESCRIPTION

- A. Scope: CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified, and required to install and test all meter equipment specified herein
- B. Related Sections:
 - 1. Section 400531 Polyvinyl Chloride Process Pipe

1.2 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Product Data:
 - a. Submit product data on each type of meter and accessories, including gaskets, hardware, and appurtenances sufficient to demonstrate compliance with the Contract Documents.
 - b. Submit operations and maintenance manuals.
- B. Informational Submittals: Submit the following:
 - 1. Certificates:
 - a. When requested by ENGINEER submit certificate attesting to compliance with standards referenced in this Section, signed by manufacturer.
 - 2. Manufacturer's Instructions:
 - a. Provide instructions for handling, storing, installing, and adjusting of products.

PART 2 -- PRODUCTS

2.1 FLOW METER SCHEDULE:

The following schedule shall be used for providing flow meters for this project.

FLOW METER SCHEDULE					
PIPING SYSTEM	TAG NUMBER	SIZE (inches)	TYPE	DISPLAY MOUNTING	
Effluent Inflow	N/A	6"	Mag Meter	Remote	

2.2 MAGNETIC FLOWMETER:

- Magnetic flowmeter shall be installed as indicated in the construction drawings. The Α. meter shall be Badger M-3000 or an approved equal suitable for measuring flows in a Class 1 Division 2 environment, unless otherwise indicated in the meter schedule as "unrated space". The meter output shall be a 4-20 mamp instantaneous flow signal and pulse output for totalized flow. Magnetic meter shall be 24 volt direct current. The meter shall be provided with ANSI B16.5 Class 150 flanges. The remote readout shall provide both an instantaneous flow rate and a totalized flow reading. The meter shall be equipped with a low flow cutoff programmable from 0-100% of maximum flow. The meter shall be furnished with a LCD display for programming the meter. The meter shall be capable of providing flow readings in either gallons/minute or million gallons/day. The meter shall have the capability to program noise damping. The meter accuracy shall be no less than 0.25% at flow velocities of greater than 1.64 feet per second and 0.004% at flow velocities less than 1.64 foot per second. The meters shall function within a temperature range of -4 to 122°F. Flow meter shall have capabilities for a remote readout. Flow meter shall be equipped with factory supplied grounding rings.
- B. Where required in the drawings and meter schedule, the transmitter (electronics unit) shall be a remote unit, to be remotely mounted from the flow tube. The factory cable connecting the flow tube and electronics unit shall be a minimum of 25 feet long or as indicated on the drawings.
- C. The flow meter shall measure and record flow in one direction only, bi-directional flow measuring shall be disabled. In the event the flow meter/pipe is empty, the flow meter shall stop reading. Flow readings shall resume upon full pipe conditions. All alarms for empty pipes shall be disabled.
- D. The transmitter (electronics unit) shall be provided for 24 VDC power supply. 24 VDC power will be provided to the unit.

PART 3 -- EXECUTION

- 3.1 GENERAL:
 - A. The CONTRACTOR shall familiarize himself with all information concerning the equipment including the installation requirements and operation characteristics. The equipment shall be installed in accordance with the recommendations of the manufacturer.
- 3.2 ACCEPTANCE TESTS:
 - A. After installation of the equipment, the CONTRACTOR shall operate each unit to demonstrate its ability to perform its specified function. A manufacturer's representative shall inspect and calibrate each of the flow meters. The manufacturer's representative shall provide instruction to the OWNER'S representative in the operation and calibration of the flow meters.

3.3 FIELD SERVICE

A. Upon startup, the manufacture of the flow meter shall provide a qualified representative for on (1) trip and one (1) day to inspect and adjust the installed equipment and provide training for the operational staff.

- END OF SECTION -

PART 1 -- GENERAL

- 1.1 DESCRIPTION
 - A. Scope: Contractor shall provide all labor, materials, equipment and incidentals as shown, specified, and required to install and test the hoist for removing the UV modules from the channel and placing them on the maintenance pad outside of the existing basin.
- 1.2 SUBMITTALS
 - A. Action Submittals: Submit the following:
 - 1. Product Data:
 - a. Submit product data on hoist and accessories, including winch, wire rope, hardware, and appurtenances sufficient to demonstrate compliance with the Contract Documents.
 - b. Submit operations and maintenance manuals.
 - B. Informational Submittals: Submit the following:
 - 1. Certificates:
 - a. When requested by ENGINEER submit certificate attesting to compliance with standards referenced in this Section, signed by manufacturer.
 - 2. Manufacturer's Instructions:
 - a. Provide instructions for handling, storing, installing, and adjusting of products.

PART 2 -- PRODUCTS

- 2.1 HOIST
 - A. The hoist shall be installed as indicated in the construction drawings. The hoist shall be a Captain series 571M1 manufactured by Thern Winches & Cranes, or approved equal suitable for lifting the UV modules out of the channels and on to the maintenance pad. The base, mast, boom, and winch shall be supplied by the same manufacturer. All exposed metal and welds shall have an epoxy finish.
 - B. The hoist shall have a minimum picking capacity of 1,000 lbs.
 - C. The hoist shall be supplied with a ratchet style screw-jack to adjust the height and reach of the hoist. The hoist mast and boom shall rotate smoothly to pivot the load outside of the existing basins.

- D. A hand winch shall be integrated with the hoist having a spur or worm gear operation and brake for load control.
- E. A minimum of 45 feet of ¼-inch 304 stainless steel wire rope shall be supplied with the hoist/winch. A stainless steel eye hook and swaged ball fitting shall be attached to the lifting end of the wire rope.

PART 3 -- EXECUTION

3.1 GENERAL

- A. The CONTRACTOR shall familiarize himself with all information concerning the equipment including the installation requirements and operation characteristics. The equipment shall be installed in accordance with the recommendations of the manufacturer.
- 3.2 ACCEPTANCE TESTS:
 - A. After installation of the equipment, the CONTRACTOR shall operate each unit to demonstrate its ability to perform its specified function.

- END OF SECTION -
Appendix A

Glasco UV Disinfection System Submittal

GLASCO UV WILL PROVIDE A VCS-40-HO x 2 UV SYSTEM AS PER THE FOLLOWING: November 17, 2017 - Updated ULTRAVIOLET DISINFECTION EQUIPMENT

PART 1 GENERAL

1.1 WORK INCLUDED

Glasco UV will supply a fully functional UV disinfection system with all required and specified components.

- 1. Two (2) Vertically oriented UV modules. Each module will have 40 low-pressure high output lamps. Module has UV monitoring system.
- 2. PLC will be capable of taking a 4-20mA flow signal and cycling modules.
- 3. Fixed level control weir
- 4. Spare parts
- 5. Start up testing, personnel training
- 6. Automatic quartz cleaning

1.1.1 ENGINEER REVIEW

- 1. Each UV module weighs 320 lbs (See attached cut sheets for Hoists as a recommendation)
- 2. Electrical Schematics are attached. Ethernet in is not required but a flow meter signal is whether it is via an ethernet or a 4-20ma is required to run the UV system in Auto Mode. A Phone Line / Auto dialer is not provided as mentioned on the markups
- 3. The PDC/SCC requires 240V 1 Phase 2 Wire, 30 AMP power. The air compressor can be powered by the PDC/SCC or via a dedicated 120V receptacle. If powered from the PDC/SCC this will be the responsibility of the contractor to make the connection. Glasco will provide a 10 amp breaker inside the panel to wire to.

1.2 PROJECT DESCRIPTION

The City of Thorne Bay will convert their existing chlorine contact chamber to a vertical UV disinfection system for disinfecting water as described in this document. The equipment, which will be supplied by Glasco UV, will be designed to work outdoors.

1.3 EQUIPMENT QUOTE PROPOSAL (as already submitted).

An in depth proposal has already been provided to the City. This accepted proposal is the basis of this submittal.

1.4 SYSTEM DESIGN CRITERIA:

Open Channel
Vertical
Outdoors
2 (1 duty, 1 redundant)
24"
Existing

Facility design peak:	0.420 mgd
Facility design avg:	0.140 MGD
TSS:	<30 mg/l
BOD:	<30 mg/l
UV Transmittance:	65%
Fecal coliform:	200/100 ml average
	800/100 ml max day
Water temperature:	8 to 20 C
Air temperature min:	-4F
Air temperature max:	90F

2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. General

The UV disinfecting system will be furnished complete with low pressure high output vertical UV modules, stainless steel mounting brackets, power distribution center, automatic level controller, UV intensity monitoring system and automatic wiping system.

An Allen Bradley PLC will be provided to perform flow pacing in relation to a 4- 20mA plant flow signal.

- B. Glasco UV will provide all the specified equipment.
- C. Glasco UV has been manufacturing this system for 15 years.
- D. UV system will be vertical in a uniform staggered array.
- E. System has been designed to treat a peak flow of .42 MGD as described in this document.
- F. The system will be retro-fitted into an existing chlorine contact chamber.
- G. All metal components not in contact with plant effluent and/or UV light will be Type 304L SS.
- H. All wiring that is exposed to UV will be coated in Teflon.
- All metal components exposed to or in contact with plant effluent, including all anchoring hardware, will be Type 304L or 316L SS. All materials exposed to UV light shall be unaffected by prolonged exposed to same and shall be Type 304L or 316L SS, Type 214 quartz, Viton, EPDM or Teflon.
- J. All welded metal in contact with the effluent will be type 316 stainless steel.
- K. The UV system will be able to continuously provide disinfection while replacing UV lamps, quartz sleeves, and ballasts and while cleaning the UV lamp sleeves.

2.2 SYSTEM PERFORMANCE

- A. The UV dosage provided with be 50 mJ with a 65% UV transmittance at end of lamp life with fouling.
- B. The system has been based on the following calculations as outlined in the US EPA UV Design Manual (EPA/635/1-86-021).

1.	UV Transmission:	65% UVT
2.	UV end of lamp life:	90%
3.	Quartz fouling:	0.90

C. The retention time is not less than 0.9 time the theoretical retention.

A. Glasco will provide low-pressure high output (GHO36T5L style) lamps for this project.

The UV lamps being provided have the following characteristics:

- 1. 90% of the UV emission will be in the 254 nm range.
- 2. The minimum UV intensity will be 370 microwatts per square cm at a distance of 1 meter.
- 3. Maximum power consumption on the 85-watt lamps.
- 4. The UV lamps have a rated UV output of 27.0 UVC watts.
- 5. The UV lamps have an arc length of 29", which will be submerged to insure proper disinfection.
- 6. Lamp life is 13,000 hours.
- 7. The UV lamp bases will be constructed of metal and ceramic, which are resistant to UV light and ozone.
- B. UV LAMP GUARANTEE:
- 1. UV supplier warrants that after 13,000 hours of operation the average UV lamp output will be no less than 90% of a new lamp (after 100 hours initial burn-in).
- 2. The number of UV lamps required will be as determined sufficient by the UV manufacturer to meet the required disinfection standard and the minimum UV dosage specified.
- 3. The UV lamps will be warranted for 13,000 hours of useful life and the warranty is to be pro-rated against actual lamp use.

2.4 UV LAMP SLEEVES

- A. Sleeves will be clear fused quartz circular tubing as by GE Type 214. Sleeves will be rated for transmittance of 94 percent or more and sleeve will not be subject to solarization over its life.
- B. One end of each sleeve will be closed and the other end sealed by a lamp end seal and compressed O-ring. The closed end of the sleeve will be held in place by means of a retaining O-ring. The sleeve will not come in contact with any steel in the frame.

The size of the quartz material will be 25 mm x 28 mm.

2.5 UV LAMP MODULE

- A. The UV module shall be fitted in a vertical position within the effluent flow channel.
- B. Each UV module consists of forty (40) lamps with each lamp placed in their individual quartz sleeve. In the event that a quartz sleeve breaks no other lamps will be exposed to the effluent.
- C. Each module is constructed from Type 316 stainless steel and with a modified NEMA 4X rating. The module is electropolished.
- D. Modules are constructed in a manner not to allow UV light to radiate above the

channel when the lamp modules are energized and fully immersed in the effluent. Modules shall be designed such that operating personnel at the plant can change the lamps and quartz sleeves with other modules in the channel still operating.

- E. The modules shall be directly wired to the power center in a UL watertight flexible conduit. Each channel shall require stainless steel wireways as provided by the UV manufacturer.
- F. The modules will be removed by lifting out of channel by hoist as supplied by others.
- G. The sleeve nut does not require special tools for removal.
- H. Automatic Cleaning System has been provided.
- I. All lamp connections will be made by Glasco UV and tested.
- J. Ballast Cooling System

1. The UV module has been designed to be used in an outdoor environment. Ballasts will be cooled by a closed loop cooling system.

2.6 UV INTENSISTY SENSOR

- A. Each module will have one (1) UV intensity sensor.
- B. The sensor will be enclosed in a watertight stainless steel probe that will be placed into its own Quartz sleeve and cleaned.
- C. The UV sensor is enclosed in its own sleeve.
- D. Sensor is able to be removed without system shut down to inspect.
- E. The sensor will be solar blind and shall measure only the germicidal spectrum wavelength (254 nm).
- F. The UV intensity shall be displayed in the UV module window kit through a digital meter with a 0 to 100% output reading.

2.7 AUTOMATIC CLEANING SYSTEM

- A. An automatic quartz cleaning system has been integrated. Glasco will provide an air compressor to actuate the automatic cleaning system.
- B. Module does not need to be removed for maintenance.
- C. The UV wiping system is fully functional and allows for disinfection. All lamps are on during the cleaning process.
- D. Cleaning cycles are user definable and allow for the selection of when to clean and then for how long to clean.
- E. The UV wiper integrates EPDM wiper material. This is in contact with the sleeves. No metal is in contact with the sleeves.

- F. Cleaning controls are capable of being remotely actuated.
- G. UV system has been provided with a pneumatic cleaning system. Air compressor shall be sized for a minimum air flow of 5 cfm @ 40 psi.
- H. Air compressor will be independently powered by the customer.
 - 1. Control of the air compressor will be via pressure switch mounted on the air receiver.
 - 2. Air outlet will be 1/4" FNPT.
 - 3. Air compressor will be v-belt driven.
 - 4. Accessories
 - a) Air Receiver
 - i Air receiver will be 13 gallon, cast iron construction.
 - 5. Motor
 - a) Motor will be 2 HP, 120 VAC, 50/60hz, 1ph 15 amps
 - 6. The air compressor discharge piping shall include:
 - a) ASME safety valve
 - b) Festo Filter/Regulator
 - c) Norgren Excelon 74 Desiccant Compressed Air Dryer

2.8 Level Control Weir

- A. Glasco will provide a level control weir to be manufactured from Type 304 stainless steel.
- B. The effluent water level shall be maintained at 29.5" (+/- 1.5") and will be installed in the discharge end of the channel.

2.9 ELECTRICAL

- A. The UV disinfection system will be divided into electrical sub-systems. There will be two (2) UV disinfection modules. Each module is capable of 100% of the flow. Therefore, there is 100% redundancy.
- B. All electrical panels are 304L stainless steel modified NEMA 4x for outdoor use.
- C. The modules will connect to the remote Power Distribution Center in pre wire and pre conduited cables.
- D. All terminations between the UV equipment and modules will be as done by Glasco. Contractor will be responsible for brining protected power to the Power Distribution Center.
- E. All critical components have been designed for the elements.

2.10 POWER DISTRIBUTION CENTER (PDC)

- A. The Power Distribution Center (PDC) has sealed receptacles, which allow for the connection of cables to the UV modules.
- B. The PDC will be a NEMA 4x modified enclosure as shown on the attached drawings.
- C. The Power Distribution Center will be NEMA 4x 304L enclosure by Hoffman.

2.11 INSTRUMENTATION AND CONTROLS:

- A. System Control Center (SCC)
- 1. One Power Distribution Center (PDC) complete with System Control Center (SCC) PLC and HMI will be provided. The floor mounted PDC is a NEMA 4X and will be conveniently located as shown on the drawings. The minimum size of the PDC is 60 inches in height, 36 inches width, and 12 inches depth.
- 2. The SCC will gather data form the modules, control lamps and distribute information to the plant operators. The PDC SCC will have the following:
 - a. One (1) HOA per module
 - b. Circuit breakers per module
 - c. Allen Bradley MicroLogix 1400 PLC
 - d. Rohtek touch screen operator user inteface
- 3. The SCC will display the following:
 - a. Module (on/off status)
 - b. UV intensity
 - c. Module temperature status
- 4. The SCC will provide volt free contacts for remote monitoring. The auto dialer being used in the Sensaphone Express II.

• The dialer shall be capable of storing a minimum of eight (8) telephone, pager, or cell phone numbers.

• Dialer shall be capable of conveying a minimum of four (4) prerecorded messages - indicating the specific system failure.

- Automatically redials for busy or unanswered numbers.
- Remote turn off feature allows termination of activated channel.
- EEPROM memory retains program despite power loss.
- Listen in verification allows two way voice communication.
- Provide with necessary power supply.
- Dialer is provided with Built in line seizure.
- A. UV major alarm this alarm shall be triggered if any one (1) of the following conditions occur: i. UV intensity low low
 - ii. UV module high temperature
 - iii. High lamp hours
 - iv. UV module failure
- B. UV minor alarm this alarm shall be triggered if any one (1) of the following conditions occur: i. UV intensity low

ii. Either module is switched to Manual Off

5. In the event of failure, the redundant module will be automatically powered on.

2.12 MANUALS

- A. Glasco UV will provide 4 detailed operation and maintenance data for each component of the system. The instructions manual shall include:
 - 1. Safety Precautions
 - 2. Protective Equipment and Clothing
 - 3. Technical Data, including detailed descriptions of SYSTEM operation, and each component.
 - 4. Installation data, procedures and recommendations

1

- 5. Operation instructions, including startup and shutdown procedures and sequence.
- 6. Service and Maintenance data, include all information and instructions required by plant personnel to keep equipment properly cleaned, lubricated and adjusted so that it functions economically throughout its full design life.
- 7. Illustrations or drawings.
- 8. Project Parts List.
- 9. Name, address and phone number of manufacturer and manufacturer's local service representative.

2.13 SPARE PARTS AND SAFETY EQUIPMENT

- 1. Lamps 8
- 2. Sleeves 8
- 3. Ballasts 4
- 4. Wiper seals 8
- 5. Wiper rings 8
- 6. Operators kit

3 EXECUTION

3.1 SHIPPING AND EQUIPMENT DELIVERY

A. All equipment and materials shall be inspected against approved Shop Drawings at time of delivery. Equipment and materials damaged or not meeting requirements of the approved Shop Drawings shall be immediately returned to GLASCO for replacement or repair.

B. The CONTRACTOR will handle and store the equipment and materials in a dry location and protect them from the elements according to the manufacturer's instructions

3.2 COMMISSIONING AND START UP

- A. Glasco UV will inspect equipment installation, piping and wiring to ensure proper installation of each component in accordance with approved submittals. CONTRACTOR shall make at its own cost any modifications required to meet GLASCO's installation recommendations. A written statement certifying that the equipment has been properly installed and interconnected shall be provided by GLASCO.
- B. Glasco UV will coordinate commissioning of the system and verify that each component of the UV System is ready for operation. UV System commissioning will include testing and calibration of each component of the system. A written statement certifying that the UV System has been commissioned and is ready for operation shall be provided.
- C. Glasco UV will coordinate initial UV System start-up to ensure operating procedures are followed in accordance with approved submittal's instructions manuals.
- D. Glasco UV will provide start up.

3.3 TRAINING

A. Glasco UV will provide operator training at the site for a period no less than one (1) 8-hr day. Training will include operation, maintenance and trouble shooting for each component of the UV System.

3.4 WARRANTY

- A. The UV System will be free from defects in materials and workmanship for a period of 24 months from Final Acceptance of the system.
- B. Lamps will be warranted for a period of 13,000 hours operating time under normal operating conditions.

1. The lamp warranty will cover the full replacement cost for the first 1,000 hrs of operation.

2. The lamp warranty will cover the lamp replacement cost on a prorated basis after 1,000 hrs operation.

END



RAVING CONTAINS DESIGNS AND OTHER REFORMATION WHICH ARE	
ROPERTY OF GLASCO UV. LLC. CONTROL NO UMMAN LAW WHEN AND ROPERTY OF GLASCO UV. LLC. CREATE FOR RIGHTS EXPRESSLY THED BY CONTRACT TO THE UNITED STATES GOVERNMENT, THIS BY MAY NOT, TWANGE ON N PART BE DUPLICATED OR DISCUSSED BY MAY DE THE REMISSION OF GLASCO UV. LLC. CONTINUE REMISSION OF GLASCO UV. LLC. CONTINUE REMISSION OF GLASCO UV. LLC. CONTINUE REMISSION OF GLASCO UV. LLC.	Glasco UV 126 Christie Avenue, Mahwah, NJ 07430 PH: 201-934-3348 FX: 201-934-3348 WWW.GLASCOUV.COM
Immediation Immediation LERERGES UNLESS MATERIAL Markensis XX = 2.005 XX = 2.015	D GLOW-VCS-40HO-LB (X2)
NOT SCALE DRAWING APVD RV 11/2/17	SCALE N/A SHEET 1 OF 2

DESCRIPTION

REV

DATE APPROVED





	REV			DESCRI	PTION	DATE	APPROVED
					10	,, ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	
Z 30 AMP SI	=RVI(CE					
THE DRAVING CONTAINS PROPERTY OF CLASCOU BY CONTRACT TO THE WI MONUFACTOR OF THE P WRITTEN PERMISSION OF PROJECT Thorne Bay ToneRWISE SPECTES X = 1 and X = 2 and X = 3 and X = 3 and X = 3 and X = 3 and	DESIGNE AND / LLC: EXCEPT THED STATES GLASCO UV L FINIS MATEI DWN	OTHER INCOME THE RECITS IN CONSTRUCTS IN THE OR DISCLE DO OR DISCLE THE	NTICH WHICH ARE THE SPERSSLY GRANTED HIS DRAWING MAY BED OR USED FOR SUIT THE PROS 10/30/2017	TITLE SIZE D	Glasco UV 126 Christie Ave Mahr PH: 201-934-3348 FX SCC/PCC PA DWG. NO.	V, LLC wah, NJ 07430 201-934-3388 ANEL LAYC	DUT 0











571 572 CAPTAIN SERIES

Designed for permanent installation and smooth rotation, the Captain Series provides extended height and reach, and still only requires a 6" concrete floor for installation.



Up to 2200 lb Capacity Stationary Davit Cranes

- Adjustable Boom Angle*
- Bearings for Smooth 360° Rotation
- Manual or Power Winch Operation
- Two Corrosion-Resistant Finishes
- Mast Locks in Four Positions
- Up to 350' Long Lift Capability
- 2-Year Warranty

*With ratchet-style screw-jack option



HAND / POWER / HYDRAULIC / AIR WINCHES • DAVIT CRANES Winona, MN USA I www.thern.com

CONFIGURATIONS



🖻 CAPTAIN

Stationary Davit Cranes

Hand or Power Winch Operation Up to 2200 lb capacity

■ Hand Winch Operated Models include spur gear or worm gear hand winch with brake for load control. Model 571M2 can be drill driven, 300 rpm max.

Power Winch Operated Models include 115 volt 1 phase AC electric winch with pendant control and brake. Other power options available, please contact factory.

- Fixed Boom Boom Position C.
- Adjustable Boom Option adjusts between Boom Position A and D – with hand operated ratchet style screw-jack, used to adjust height and reach. Optional screw-jack sold separately.
- Mast and Boom Rotate on tapered roller bearings for smooth 360° load movement. Mast locks in one of four position with hand tightened lock bolt. Handle on the mast makes rotation easy.
- Gusset Style Base for permanent installation and stability under load.
- **Epoxy Finish** available for improved protection against corrosion.
- Wire Rope Assemblies sold separately. See tables on following pages.
- Two-year Limited Warranty

sold separately)

Captain 1500 and Captain 2200 - Crane Configurations and Options

Model	Description	Approx Wei	k. Ship ght	
		(lb)	(kg)	
571M1	Up to 1500 lb – with M4312PB-K spur gear hand winch	425	193	
571M2	Up to 1500 lb – with 4WM2V-K worm gear hand winch	450	205	
571E2	Up to 1500 lb – with 4WP2-K electric winch – 115 VAC, 1 phase, 6 ft pendant control	475	216	
571E4	Up to 1500 lb – with 4777-K electric winch – 115 VAC, 1 phase, 6 ft pendant control	489	222	
572M1	Up to 2200 lb – with M452B-K spur gear hand winch	720	327	
572E2	Up to 2200 lb – with 3WG4B-K electric winch – 115 VAC, 1 phase, 6 ft pendant control	970	440	
572E3	Up to 2000 lb – with 4771-K electric winch – 115 VAC, 1 phase, 6 ft pendant control	750	341	
572E5	Up to 2200 lb – with 4WS3M6-K electric winch – 115 VAC, 1 phase, 6 ft pendant control *	1050	477	
SJ1	Ratchet style screw-jack for Series 571 (replaces standard boom brace)	37	17	
SJ2	Ratchet style screw-jack for Series 572 (replaces standard boom brace)	97	44	

* Other configurations also available. Please contact factor or nearest Thern Distributor for firm fixed price and delivery.

DIMENSIONS





Hook Reach and Height

Series	Boom Position	Hook	Reach	Hook	Height	
		(in)	(mm)	(in)	(mm)	
571	A ¹	87.88	2232.1	56.00	1422.4	
	B ¹	81.25	2063.7	90.00	2286	
	C (fixed)	74.56	1893.8	102.00	2590.8	
	D1	62.25	1581.1	118.00	2997.2	' 12 2
572	A ¹	106.75	2711.4	64.00	1625.6	
	B1	95.50	2425.7	112.00	2844.8	Dimensions are for reference only
	C (fixed)	84.25	2139.9	130.00	3302	and subject to change without house.
	D1	75.00	1905	140.00	3556	the screw-jack option.

Crane Dimensions

	Serie	es 571	Serie	s 572
	(in)	(mm)	(in)	(mm)
F	67.19	1706.6	77.41	1966.2
G	32.88	835.1	38.62	980.9
H	131.19	3332.2	155.75	3956.0
Q	16.00	406.4	20.00	508
R	18.00	457.2	23.00	584.2
S (hole dia.)	.56	14.2	.81	20.5

Dimensions are for reference only and subject to change without notice.

IMPORTANT:

Load rating will vary with wire rope length and boom position. Please see Performance Characteristics table on the following page.



IMPORTANT:

It is the owner or operator's responsibility to determine the suitability of the equipment to its intended use. Study all applicable codes, manuals and regulations. Be sure to read the Owner's Manual supplied with the equipment before operating it.





IMPORTANT:

Base installation is purchaser's responsibility. Thern recommends consulting a civil engineer or other qualified professional.

PERFORMANCE

WIRE ROPE ASSEMBLIES - sold separately

■ Galvanized or Stainless Steel wire rope assemblies.

Wire Rope Assemblies

Γ

Model Number	Wire Rope Diameter x Length	App Ship V	rox. Veight
		(lb)	(kg)
Galvanized aircraft cable with	swivel hook and swaged ball fitti	ing.	
WA25-28NS	1/4 in x 28 ft	5	2.3
WA25-36NS	1/4 in x 36 ft	6	2.7
WA25-45NS	1/4 in x 45 ft	7	3.2
WA25-60NS	1/4 in x 60 ft	9	4.1
WA25-75NS	1/4 in x 75 ft	11	5.0
304 Stainless steel wire rope Swivel hook also available. Pl	with SS eye hook and swaged ba lease call factory.	all fitting.	
WS25-28NS	1/4 in x 28 ft	5	2.3
WS25-36NS	1/4 in x 36 ft	6	2.7
WS25-45NS	1/4 in x 45 ft	7	3.2
WS25-60NS	1/4 in x 60 ft	8	3.6
WS25-75NS	1/4 in x 75 ft	11	5.0
Galvanized aircraft cable with	swivel hook and unfinished end.		
WA31-28DS	5/16 in x 28 ft	7	3.2
WA31-36DS	5/16 in x 36 ft	8	3.6
WA31-45DS	5/16 in x 45 ft	10	4.5
WA31-60DS	5/16 in x 60 ft	12	5.4
WA31-75DS	5/16 in x 75 ft	15	6.8
304 Stainless steel wire rope Swivel hook also available. Pl	with SS eye hook and unfinished lease call factory.	end.	
WS31-28DS	5/16 in x 28 ft	7	3.2
WS31-36DS	5/16 in x 36 ft	9	4.1
WS31-45DS	5/16 in x 45 ft	11	5.0
WS31-60DS	5/16 in x 60 ft	14	6.4
WS31-75DS	5/16 in x 75 ft	17	7.7

Please contact factory or nearest Thern Distributor for firm, fixed price and delivery.

Captain 1500 Performance Characteristics

IMPORTANT:

It is the owner or operator's responsibility to determine the suitability of the equipment to its intended use. Study all applicable codes, manuals and regulations. Be sure to read the Owner's Manual supplied with the equipment before operating it.

Positions A, B and D require separate order of ratchet style screw-jack.





-																							
	Wire F	Rope	2		57	Loa 71M1,	ad Ra 571N	tings 12 anc	for 571	E2			L	oad R	ating	s for 5	571E4	1		Lif	t Belo Lev	ow F /el ²	loor
D	ia.	Le	ngth	Pos	s A	Pos	s B	Pos	s C	Pos	s D	Pos	s A	Pos	s B	Pos	s C	Pos	s D	Μ	lin	N	lax
(in)	(mm)	(ft)	(m)	(lb)	(kg)	(lb)	(kg)	(lb)	(kg)	(lb)	(kg)	(lb)	(kg)	(lb)	(kg)	(lb)	(kg)	(lb)	(kg)	(ft)	(m)	(ft)	(m)
1/4	6.35	28	8.53	1200	544	1350	612	1500	680	1500	680	1200	544	1350	612	1500	680	1500	680	4	1.21	9	2.74
1/4	6.35	36	10.97	1200	544	1350	612	1500	680	1500	680	1200	544	1350	612	1500	680	1500	680	12	3.65	17	5.18
1/4	6.35	45	13.71	1200	544	1350	612	1400	635	1400	635	1200	544	1350	612	1500	680	1500	680	21	6.40	26	7.92
1/4	6.35	60	18.28	1200	544	1300	589	1300	589	1300	589	1200	544	1350	612	1400	635	1400	635	36	10.97	41	12.49
1/4	6.35	75	22.86	_	_	_	_	_	_	_	_	1200	544	1300	589	1300	589	1300	589	51	15.54	56	17.06

¹ Add 2 feet to lift below floor level for Model 571E4.
² Lift below floor level varies depending on boom position and winch configuration. For longer lifts, contact factory.

Captain 2200 Performance Characteristics

	Wire F	Rope	•		57	Loa 72M1,	ad Ra 572E	tings 2 and	for 572E	5 1			L	.oad R	ating	s for 5	572E3	; 1		Lif	t Belo Lev	w Fi el ²	loor
D	ia.	Le	ngth	Pos	s A	Pos	s B	Pos	s C	Pos	s D	Pos	s A	Pos	s B	Pos	s C	Pos	s D	N	lin	N	lax
(in)	(mm)	(ft)	(m)	(lb)	(kg)	(lb)	(kg)	(lb)	(kg)	(lb)	(kg)	(lb)	(kg)	(lb)	(kg)	(lb)	(kg)	(lb)	(kg)	(ft)	(m)	(ft)	(m)
5/16	7.93	28	8.53	1700	771	2000	907	2200	997	2200	997	1700	771	1700	771	1700	771	1700	771	<1	< 0.30	5	1.52
5/16	7.93	36	10.97	1700	771	2000	907	2200	997	2200	997	1700	771	1700	771	1700	771	1700	771	7	2.13	13	3.96
5/16	7.93	45	13.71	1700	771	2000	907	2200	997	2200	997	1500	680	1500	680	1500	680	1500	680	16	4.87	22	6.70
5/16	7.93	60	18.28	1700	771	2000	907	2200	997	2200	997	1300	589	1300	589	1300	589	1300	589	31	9.44	37	11.27
5/16	7.93	75	22.86	1700	771	2000	907	2200	997	2200	997	1300	589	1300	589	1300	589	1300	589	46	14.02	52	15.84

¹ Add 3 feet to lift below floor level for Model 572E2, 572E3 and 572E5.
² Lift below floor level varies depending on boom position and winch configuration. For longer lifts, contact factory.



Corporate Headquarters 5712 Industrial Park Road PO Box 347 Winona, MN 55987 USA

507-454-2996 phone facsimile 507-454-5282 email info@thern.com web www.thern.com

Thern Europe Bedrijvenpark Twente 454e 7602 KM Almelo The Netherlands

+31 548 659052 phone facsimile +31 548 659010 email europe@therneurope.eu www.therneurope.eu

web

Crane Overturning Moments & Bolt Reactions (Calculated at Rated Load)

					Pedesta	l Base				
Crane	Mast I	Moment	Q	R	D	S	Suggested	Axial Force	per Bolt *	
Model	in-lbs	(N-m)	inch (mm)	inch (mm)	inch (mm)	inch (mm)	Bolt Size	lbs	(N)	
5122	21,050	(2,379)	7.00 (178)	4.95 (126)	3.50 (89)	0.56 (15)	1/2" (M12)	1,990	(8853)	
5PF5	21,690	(2,451)	7.00 (178)	4.95 (126)	3.50 (89)	0.56 (15)	1/2" (M12)	2,060	(9164)	
5PA5	9,410	(1,064)	7.00 (178)	4.95 (126)	3.50 (89)	0.56 (15)	1/2" (M12)	880	(3915)	
5PA10	32,730	(3,699)	14.50 (368)	10.25 (260)	7.25 (184)	0.69 (18)	5/8" (M16)	1,380	(6139)	
5PT10	37,790	(4,270)	14.50 (368)	10.25 (260)	7.25 (184)	0.69 (18)	5/8" (M16)	1,680	(7474)	
5PT20	95,110	(10,747)	14.50 (368)	10.25 (260)	7.25 (184)	0.69 (18)	5/8" (M16)	4,240	(18862)	
571	116,280	(13,139)	16.00 (406)	11.31 (287)	8.00 (203)	0.69 (18)	5/8" (M16)	4,650	(20686)	
572	202,330	(22,862)	20.00 (508)	14.14 (359)	10.00 (254)	0.81 (21)	3/4" (M20)	6,470	(28782)	
5PT30	287,710	(32,509)	20.50 (521)	14.50 (368)	10.25 (260)	1.38 (35)	1 1/4" (M30)	9,280	(41282)	
								* Force in	Tension	

Flush Mount Base Mast Moment Q Crane R D S Suggested Axial Force per Bolt Bolt Size varies by installation. Model in-lbs (N-m) inch (mm) inch (mm) inch (mm) inch (mm) 4.95 (126) 5122 21,050 7.00 (178) 3.50 (89) 0.56 1/2" (2,379)(15) (M12) Diameter of base pipe 5PF5 21,690 3.50 0.56 1/2" (M12) (2, 451)7.00 (178) 4.95 (126) (89) (15) must be well supported. 5PA5 1/2" (M12) 9,410 (1,064)7.00 (178) 4.95 (126) 3.50 (89) 0.56 (15) 5PA10 32,730 (3, 699)14.50 (368) 10.25 (260)7.25 (184) 0.69 (18) 5/8" (M16) Minimum embedment 5PT10 37,790 7.25 (4, 270)14.50 (368) 10.25 (260)(184) 0.69 (18) 5/8" (M16) depth should be verified by a structural engineer. 7.25 (184) 5PT20 95,110 (10,747) 14.50 (368) 10.25 (260) 0.69 (18) 5/8" (M16) Mounting bolts may not be required based on the type of installation. 5PT30 (32,509) 20.50 (521) 14.50 (368) 1 1/4" (M30) 287,710 10.25 (260) 1.38 (35)

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Wall Mount Base																
Crane	Mast Moment		Q		R		D		S		Suggested		Axial Force per Bolt *		Shear Force per Bolt	
Model	in-lbs	(N-m)	inch	(mm)	inch	(mm)	inch	(mm)	inch	(mm)	Bolt	Size	lbs	(N)	lbs	(N)
5122	21,050	(2,379)	8.00	(203)	5.32	(135)	3.50	(89)	0.56	(15)	1/2"	(M12)	1,390	(6184)	1,100	(4894)
5PF5	21,690	(2,451)	8.00	(203)	5.32	(135)	3.50	(89)	0.56	(15)	1/2"	(M12)	1,440	(6406)	1,150	(5116)
5PA5	9,410	(1,064)	8.00	(203)	5.32	(135)	3.50	(89)	0.56	(15)	1/2"	(M12)	680	(3025)	540	(2403)
5PA10	32,730	(3,699)	14.50	(368)	10.25	(260)	7.25	(184)	0.69	(18)	5/8"	(M16)	1,280	(5694)	1,060	(4716)
5PT10	37,790	(4,270)	14.50	(368)	10.25	(260)	7.25	(184)	0.69	(18)	5/8"	(M16)	1,420	(6317)	1,150	(5116)
5PT20	95,110	(10,747)	14.50	(368)	10.25	(260)	7.25	(184)	0.69	(18)	5/8"	(M16)	3,560	(15837)	2,740	(12189)
5PT30	287,710	(32,509)	14.50	(368)	12.55	(319)	10.25	(260)	1.38	(35)	1 1/4"	(M30)	10,620	(47242)	6,450	(28693)
	* Force in Tension															

This information may change without prior notice. It is the responsibility of the installer and/or the end-user to ensure that the most current information is used. Mast moments and Disclaimer: bolt forces are approximate and include the weight of components of a typical assembly.

