Lower Pond Improvements Project Redesign

Construction Specifications

Issued for Pre-Final Design Draft

McMillen

June 29, 2026

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Tulalip Tribes Lower Pond Improvements Project Drawings

END OF SECTION

SECTION 01 10 00 – SUMMARY

PART 1 -- GENERAL

1.1 THE SUMMARY

A. This Section includes the following:

1. Work covered by the Contract Documents.

2. Use of premises.

3. Tribal occupancy requirements.

4. Specification formats and conventions.

1.2 WORK COVERED BY CONTRACT DOCUMENTS

A. Project Identification: Tulalip Lower Pond Hatchery Improvements

1. Project location: The existing Tulalip Creek Lower Pond hatchery is located at 7615 Totem Beach Rd., Tulalip, WA 98271.

B. Technical Coordinators:

1. Point of Contact

Michael Crewson
Tulalip Tribes
6406 Marine Drive
Tulalip, WA 98271
Phone: 360-716-4626
Email: mcrewson@tulaliptribes-nsn.gov

C. The Work includes replacement of the existing Tulalip Lower Pond facilities, to improve adult salmon holding and spawning operations, fish transfer and counting capabilities out of the Tulalip Upper Pond facility, and to improve water and sediment management.

The Tulalip Creek Ponds include both the upper holding pond (Upper Pond) and a lower holding pond (Lower Pond) with supporting facilities that include adult salmon capture, holding, and spawning. Since the facilities began service in the 1980's – the facility has been substantially unmodified.

All existing facilities will be demolished with the exception of the flow splitting box structure, the box culvert and flume, the lower pond dam, and the lower portion of the fish ladder through the dam.

Construction for [redacted] project includes the following new structures:

- *Screen Channel* – A long concrete channel with a weir and screen with the ability to concentrate fish prior to their travel through the fish counter and manage flow distribution.
- *Fish Counting Vault* – A concrete vault containing one fish counter.

- *Distribution Box* – A concrete water retaining structure consisting of several chambers to distribute water to the lower pond and raceway. Stoplogs and slide gates will be used to control the flow to the raceway and pond.
- *Lower Raceway* – One sorting raceway which allows fish to be crowded for spawning operations. The raceway will be divided into two halves longitudinally by a picket barrier to improve sorting operations.
- *Spawning Shed* – A steel canopy-covered area at the upstream end of the sorting raceway, with facilities to support spawning, sorting, and carcass removal.
- *Clarifier*– A fiberglass structure to promote settling of solids from the cleaning water prior to discharge.
- *Water Treatment Shed* – An enclosed building that will contain electrical panels for the equipment on site and water treatment equipment that is part of the partial reuse system.

In addition to new structures, a series of improvements are proposed to improve water management and hydraulics. This includes the following:

- *Flow Splitting Box Modifications* – The existing structure will be modified to improve flow control and provide the ability to bypass water around the various Lower Pond structures.
- *Water and Fish Bypass Pipes* – A surplus/bypass pipe that extends from the flow splitting box around the hatchery processes for discharge through the fish ladder will be added. Other buried pipelines convey screened water and/or fish through or around a fish counting system for ultimate discharge through either the existing fish release pipe or the fish ladder.
- *Lower Pond Modifications* – The existing earthen pond will continue to be utilized. The pond will be re-graded to improve pond hydraulics and retain sufficient volume for operations.

The project includes the following ancillary improvements:

- *Improvements to Existing Fish Ladder* – The existing fish ladder will be modified for improved hydraulics and fish passage. The stairs and walkway leading to the davit crane for lifting the fish ladder entrance barrier will be improved. Concrete stairs will be added to the face of the spillway to reach the davit crane.
- *Stormwater Detention Bioswale* – A location to the northeast of the project site will be constructed to capture stormwater runoff from a portion of Totem Beach Rd.
- *Seal Barrier Picket Replacement* – The existing seal barrier pickets will be replaced to improve performance
- *Intertidal Holding Pool Modifications* – The existing holding pond at the bottom of the fish ladder will be modified into a channel and the existing concrete weir structure will be removed and replaced.

The proposed project also includes mechanical improvements in support of the rearing operations. This includes the following:

- *Fish Counting System* – One VAKI fish counter will be installed downstream of the screen channel with a method of adjusting the flow of water through the fish counter.
- *Mechanical Crowders* – The lower sorting raceway ~~and large rearing pond~~ will be provided with self-propelled crowder systems to facilitate efficient crowding and sorting operations.

- *Water Reuse System* – Water reuse pumps provide the ability to return a percentage of hatchery flow from the tailrace back to the Distribution Box after treatment in a filtration and disinfection system. The pressurized Reuse System includes locations to connect for washdown operations or to fill a water tank on a truck.
- *Water Reuse Filtration and Disinfection System* – The pumped reuse water is routed through a small building which houses water filtration and Ultra-Violet (UV) light disinfection equipment.
- *Oxygenation System* – System for actively oxygenating water at the Distribution Box through the use of oxygen tanks that discharge through micro-bubble diffusers.
- *Flow Metering* – An electromagnetic flow meter will be installed at the supply pipe to each of the supply pipes to the lower pond and south lower raceway. A magnetic flow meter will be installed in the filtration and disinfection building to measure water reuse flows.
- *Cleaning Water Systems* – A system of piping with valved cam-lock ports extends throughout the facility to facilitate manual debris removal from the floor of rearing structures for pumped discharge to the clarifier.
- *Lower Raceway Solids Removal Pumps* – A system for pumping solids from the trench drains along the downstream end of the raceway to the clarifier.
- *Spawning Area Waste Pumps* – A system of pumping solids and wash water from the spawning area to the clarifier.
- *Fish Carcass Elevator* – Equipment to lift fish carcasses from the spawning area floor level into a cart or onto a table as needed.

D. The project will be constructed under a single prime contract.

1.3 USE OF PREMISES

A. Contractor shall have limited use of premises for construction operations as indicated on Drawings by the Contract limits.

B. Schedule operations so that Work is conducted during regular office hours which are 7:30 am to 5:00 pm.

C. Schedule and sequence operations necessary to complete the work, including coordination with other crafts relative to the Contractor's requirements. Schedule Work in such manner as to avoid delays in overall construction and permit proper installation of work.

D. Use of Site: Limit use of premises to work in areas indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.

1. Driveways and Entrances: Keep driveways, parking areas, loading areas, and entrances serving premises clear and available to Owner, public, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.

    a. Schedule deliveries to minimize use of driveways and entrances.

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

c. No parking is allowed in the parking lot of the adjacent pre-school or mental wellness center.

1.4 TRIBAL OCCUPANCY REQUIREMENTS

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 the Owner.

1.5 SPECIFICATION FORMATS AND CONVENTIONS

A. Specification Format: The Specifications are organized into Divisions and Sections using the Construction Specifications Institute (CSI) "Master Format" numbering system.

1. Division 01: Sections in Division 01 govern the execution of the Work of all Sections in the Specifications.

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

1. Abbreviated Language: Language used in the Specifications and other Contract Documents is abbreviated. Words and meanings shall be interpreted as appropriate. Words implied, but not stated, shall be inferred as the sense requires. Singular words shall be interpreted as plural, and plural words shall be interpreted as singular where applicable as the context of the Contract Documents indicates.

2. Imperative mood and streamlined language are generally used in the Specifications. Requirements expressed in the imperative mood are to be performed by Contractor. Occasionally, the indicative or subjunctive mood may be used in the Section Text for clarity to describe responsibilities that must be fulfilled indirectly by Contractor or by others when so noted.

a. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.

C. This Contract incorporates by reference selected Sections in the 2022 Standard Specifications for Road, Bridge, and Municipal Construction published by the Washington State Department of Transportation (“WSDOT Specifications”). Whenever any Division, Section, Article or Paragraph in this Contract incorporates a Section of the WSDOT Specifications, only the referenced Section is incorporated. Unless expressly stated otherwise, if an incorporated Section cross-references another Section in the WSDOT Specifications, the cross-referenced Section is not a part of the Contract and shall have no effect.

D. Any reference to the “Engineer” in an incorporated Section of the WSDOT Specifications shall mean the Construction Manager.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

SECTION 01 14 00 – CONSTRUCTION CONSTRAINTS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. WORK shall be scheduled, sequenced, and performed in a manner which minimizes disruption to the operation and maintenance of existing facilities.

B. The Contractor shall incorporate the construction and schedule constraints of this Section in preparing the construction schedules required under Section 01 32 00 - Construction Progress Documentation.

1.2 EXISTING FACILITY

A. Temporary power is available in coordination with the Owner. Temporary power, lighting, controls, instrumentation, alarms, security devices, and safety devices shall be provided by the Contractor where not available due to existing system capacity or constraints.

B. Snohomish Public Utilities District (SnoPUD) is the electrical service provider to this site. Temporary power shall be provided by SnoPUD, portable generators shall not be allowed except for short durations and with advanced approval from the Owner.

C. The construction constraints in this Section do not include every item affecting the completion of the WORK but are intended to describe the sequence of critical events necessary to minimize disruption. It shall be understood and agreed by the Contractor that the critical events described are not inclusive and that additional items of WORK not included may be required to minimize disruption and ensure compliance. Deviation from or modification of these suggested sequences is permitted if approved in advance by the Engineer.

D. Intertidal facilities include the lower portion of the fishladder access stairway, seal barrier, the concrete weir structure, and the holding pool at the base of the fish ladder.

1.3 The contractor is advised that much of the work on the lower dam fish ladder access stairs must be performed in coordination with normal tides.OPERATION OF FACILITY

A. Operational functions or shutdown of the existing facilities required to facilitate Contractor's operation will be done by the Owner's personnel only.

B. The Lower Pond site transmits all Tulalip Creek stream flows through the site to Tulalip Bay at all times of the year and these flows must continue to be managed during construction. Normal flows are conveyed through the Flow Splitting Box and high stream flows are conveyed through the box culvert under Totem Beach Rd. and the associated aluminum flume structure. Stream flows exit the Lower Pond through either the 36” diam. Fish Release Pipe, the Fish Ladder, and over the lower dam spillway.

C. The Lower Pond site also functions to transmit juvenile salmon that move from the Upper Pond (north of Totem Beach Rd.) to Tulalip Bay. The juveniles and reduced stream flows are conveyed under the lower dam via the Fish Release Pipe.

D. The Owner must have periodic access to the fish release pipe slide gate and a safe method of conveying the juveniles and stream flow through the site to Tulalip Bay must be maintained.

1.4 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 - Contractor Submittals

B. The Contractor shall provide the following temporary work plans:

1. Bypass Flow Plan - Managing the flow out of the Flow Splitting Box with discharge from the site via the existing fish ladder.

2. High Level Outlet Flow Diversion Plan – Managing the flow from the box culvert and flume structure.

3. Juvenile Fish Release Plan – Managing the water flow and the short-term flush of juvenile salmon which must safely and quickly migrate through the site to Tulalip Bay. The Tribe will provide the schedule for releases from the Upper Pond, which typically occur in late spring.

4. Intertidal Work Plan – The plan shall describe the low ground pressure tracked equipment to be used, methods used to prevent vehicle fluid spills, and to prevent the release of sediment into Tulalip Bay.

C. The Contractor shall provide their construction schedule with tasks associated with setting up the temporary facilities required for the juvenile fish releases.

D. Groundwater Dewatering Plan – Groundwater dewatering at the site requires the upper pond water surface elevation to be lowered to stream flow. Coordinate with the Owner to draw down the upper pond prior to dewatering operations. Removal of surface flow nuisance water of trenches does not require coordination.

1.5 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 and night, weekend, or holiday activity and overtime payments required during process interruptions 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.

D. When temporary electrical power, controls, instrumentation, or alarms are required for routine continuous operations of existing or new equipment, the Contractor shall provide the necessary equipment and appurtenances. Prior to installing said equipment and appurtenances, Contractor shall furnish a submittal on the proposed components and installation for Engineer's review and approval.

E. A plan showing the size and location of the temporary facilities and piping shall be submitted to the Engineer at the same time as the outage plan required under this Section. Costs for design, provision, operation, and removal of temporary facilities and piping shall be part of the WORK.

1.6 PERMITS

A. The Contractor shall abide by the conditions of permits and shall obtain proof of satisfaction of conditions from issuers of permits prior to acceptance of the WORK by the Owner.

B. Conditions affecting the Contractor are found in the following permits to be obtained by the Owner.

1. U.S. Army Corps of Engineers (USACE), NWP-3, NWP-18,/NMFS Permit

2. Section 401/Water Quality Certification

3. Tulalip Tribes Planning Department Building Permit

4. Tulalip Tribes Planning Department Grading Permit

1.7 SCHEDULE CONSTRAINTS

A. General: It is the Contractor's responsibility to coordinate and plan the construction activities to integrate each schedule constraint into performance of the overall WORK.

B. The listing of schedule constraints below does not mean that every constraint or special condition has been identified. The list does not substitute for the Contractor's coordination and planning for completion of the WORK within the Contract Times.

1. The Contractor shall maintain the ability of the High-Level Outlet box culvert and aluminum flume to pass flows around the construction area.

2. The Contractor shall maintain the ability of water discharged from the Upper Dam through the flow splitting box to reach the Fish Release Pipe for juvenile fish passage.

3. Surrounding land usage and property owner and community activities.

4. Intertidal work must be performed during low tides and low stream flows, generally between the July and the end of September. Regulatory requirements restrict intertidal work in this location to beginning no earlier than July 15 of any year.

5. Before beginning the intertidal work, the Contractor must receive approval from the Owner that an approved biologist has conducted a forage fish survey and no forage fish were observed spawning in the area and that the biologist report has been submitted to the USACE in accordance with approved permits. Upon approval from the Owner, the work must occur within two weeks.

1.8 TOOLS AND EQUIPMENT

A. Hydraulic hand tools are restricted from use.

B. Contractor may not alter tools or equipment unless approved by the manufacturer.

C. Low ground pressure tracked equipment shall be used for driving below the High Tide Line (11.20ft of elevation NAVD88)

1.9 MISCELLANEOUS CONSTRAINTS

A. **Historical River Flows:** The Tulalip Creek waterway may affect the Contractor's ability to perform at the Lower Pond site. Historical river flow data for the creek can be found at USGS gage 12158040 Tulalip Creek Near Tulalip, WA. Historical data is provided for reference at this site.

B. The following constraints may affect the construction schedule.

1. Seasonal variations in creek flowrates.

2. Planned juvenile salmon releases with dates provided by the Owner.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

SECTION 01 25 00 – SUBSTITUTION 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 administrative and procedural requirements for substitutions.

B. Related Requirements:

1. Section 01 60 00 - Product Requirements for requirements for submitting comparable product submittals for products by listed manufacturers.

1.3 DEFINITIONS

A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.

1. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.

2. Substitutions for Convenience: Changes proposed by Contractor or Tribe that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.

1.4 ACTION SUBMITTALS

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

1. Documentation: Show compliance with requirements for substitutions and the following, as applicable:

a. Statement indicating why specified product or fabrication, or installation cannot be provided, if applicable.

b. Coordination information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Tribe and separate contractors that will be necessary to accommodate proposed substitution.

c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.

d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.

e. Samples, where applicable or requested.

f. Certificates and qualification data, where applicable or requested.

g. List of similar installations for completed projects with project names and addresses and names and addresses of Owners.

h. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.

i. Research reports evidencing compliance with building code in effect for Project.

j. Detailed comparison of Contractor's construction schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.

k. Cost information, including a proposal of change, if any, in the Contract Sum.

l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents except as indicated in substitution request, is compatible with related materials, and is appropriate for applications indicated.

m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

2. Owner’s Action: If necessary, Owner will request additional information or documentation for evaluation within seven days of receipt of a request for substitution. Owner will notify Contractor of acceptance or rejection of proposed substitution within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.

a. Forms of Acceptance: Change Order, Construction Change Directive, or Owner’s Supplemental Instructions for minor changes in the Work.

1.5 QUALITY ASSURANCE

A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage a qualified testing agency to perform compatibility tests recommended by manufacturers.

1.6 PROCEDURES

A. Coordination: Revise or adjust affected work as necessary to integrate work of the approved substitutions.

PART 2 -- PRODUCTS

2.1 SUBSTITUTIONS

A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.

1. Conditions: Owner will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Owner will return requests without action, except to record noncompliance with these requirements:

a. Requested substitution is consistent with the Contract Documents and will produce indicated results.

b. Substitution request is fully documented and properly submitted.

c. Requested substitution will not adversely affect Contractor's construction schedule.

d. Requested substitution has received necessary approvals of authorities having jurisdiction.

e. Requested substitution is compatible with other portions of the Work.

f. Requested substitution has been coordinated with other portions of the Work.

g. Requested substitution provides specified warranty.

h. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

B. Substitutions for Convenience: Owner will consider requests for substitution if received within 60 days after commencement of the Work. Requests received after that time may be considered or rejected at discretion of Owner.

1. Conditions: Owner will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Owner will return requests without action, except to record noncompliance with these requirements:

a. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Owner for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.

b. Requested substitution does not require extensive revisions to the Contract Documents.

c. Requested substitution is consistent with the Contract Documents and will produce indicated results.

d. Substitution request is fully documented and properly submitted.

e. Requested substitution will not adversely affect Contractor's construction schedule.

f. Requested substitution has received necessary approvals of authorities having jurisdiction.

g. Requested substitution is compatible with other portions of the Work.

h. Requested substitution has been coordinated with other portions of the Work.

i. Requested substitution provides specified warranty.

j. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

Exhibit E.1 Page 18 of 748

SECTION 01 26 00 – CONTRACT MODIFICATION 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 administrative and procedural requirements for handling and processing Contract modifications.

B. Related Requirements:

1. Section 01 25 00 - Substitution Procedures for administrative procedures for handling requests for substitutions made after the Contract award.

1.3 MINOR CHANGES IN THE WORK

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

1.4 PROPOSAL REQUESTS

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

1. Work Change Proposal Requests issued by Owner are not instructions either to stop work in progress or to execute the proposed change.

2. Within time specified in Proposal Request or 30 days, when not otherwise specified, after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.

a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.

b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.

c. Include costs of labor and supervision directly attributable to the change.

d. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.

e. Quotation Form: Use forms acceptable to Owner.

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

1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.

2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.

3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.

4. Include costs of labor and supervision directly attributable to the change.

5. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.

6. Comply with requirements in Section 01 25 00 - Substitution Procedures if the proposed change requires substitution of one product or system for product or system specified.

7. Proposal Request Form: Use form acceptable to Owner.

1.5 CHANGE ORDER PROCEDURES

A. On Owner's approval of a Work Changes Proposal Request, Owner will issue a Change Order for signatures of Tribe and Contractor.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

SECTION 01 29 00 - PAYMENT 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 administrative and procedural requirements necessary to prepare and process Applications for Payment.

B. Related Requirements:

1. Section 01 26 00 - Contract Modification Procedures for administrative procedures for handling changes to the Contract.

2. Section 01 32 00 - Construction Progress Documentation for administrative requirements governing the preparation and submittal of the Contractor's construction schedule.

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.

1.4 SCHEDULE OF VALUES

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

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

a. Application for Payment forms with continuation sheets.

b. Submittal schedule.

c. Items required to be indicated as separate activities in Contractor's construction schedule.

2. Submit the schedule of values to Owner at earliest possible date, but no later than seven days before the date scheduled for submittal of initial Applications for Payment.

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

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

a. Project name and location.

b. Name of Owner.

c. Owner’s project number.

d. Contractor's name and address.

e. Date of submittal.

2. Arrange schedule of values consistent with format of American Institute of Architects (AIA) Document G703.

3. Arrange the schedule of values in tabular form with separate columns to indicate the following for each item listed:

a. Related Specification Section or Division.

b. Description of the Work.

c. Name of subcontractor.

d. Name of manufacturer or fabricator.

e. Name of supplier.

f. Change Orders (numbers) that affect value.

g. Dollar value of the following, as a percentage of the Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent.

1) Labor.

2) Materials.

3) Equipment.

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

a. Include separate line items under Contractor and principal subcontracts for Project closeout requirements in an amount totaling five percent of the Contract Sum and subcontract amount.

5. Round amounts to nearest whole dollar; total shall equal the Contract Sum.

6. Provide a separate line item in the schedule of values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.

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

7. Provide separate line items in the schedule of values for initial cost of materials, for each subsequent stage of completion, and for total installed value of that part of the Work.

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

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

1.5 APPLICATIONS FOR PAYMENT

A. Measurement will be in accordance with a reasonable apportionment of the work as established in the Schedule of Values.

B. Payment will be based upon the percentage of completion for each appropriate line item in the Schedule of Values.

C. Invoices and corresponding schedule of values line item are submitted to the Tulalip Tribes' Contract Officer and Construction Director as described in Division 00.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

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SECTION 01 31 00 - PROJECT MANAGEMENT AND COORDINATION

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

1. General coordination procedures.

2. Requests for Information (RFIs).

3. Project meetings.

B. Each contractor shall participate in coordination requirements. Certain areas of responsibility are assigned to a specific contractor.

C. Related Requirements:

1. Section 01 32 00 - Construction Progress Documentation for preparing and submitting Contractor's construction schedule.

2. Section 01 73 00 - Execution for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.

3. Section 01 77 00 - Closeout Procedures for coordinating closeout of the Contract.

1.3 DEFINITIONS

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

1.4 INFORMATIONAL SUBMITTALS

A. Subcontract List: Contractor shall submit a list of proposed subcontractors and the work to be performed by each.

B. Key Personnel Names: Within 14 days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home, office, and cellular telephone numbers and e-mail addresses. Provide names, addresses, and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to Project.

1.5 GENERAL COORDINATION PROCEDURES

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

1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.

2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.

3. Make adequate provisions to accommodate items scheduled for later installation.

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

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

1.6 REQUESTS FOR INFORMATION (RFIS)

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

1. Contractor shall submit RFIs directly to the Owner. Owner will return RFIs submitted by other entities controlled by Contractor ,with no response.

2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.

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

1. Project name.

2. Project number.

3. Date.

4. Name of Contractor.

5. Name of Owner.

6. RFI number, numbered sequentially.

7. RFI subject.

8. Specification Section number and title and related paragraphs, as appropriate.

9. Drawing number and detail references, as appropriate.

10. Field dimensions and conditions, as appropriate.

11. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.

12. Contractor's signature.

13. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.

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

C. RFI Forms: Form with substantially the same content as indicated above, acceptable to Owner.

1. Attachments shall be electronic files in PDF format.

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

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

    a. Requests for approval of submittals.

    b. Requests for approval of substitutions (submit a request for substitution).

    c. Requests for approval of Contractor's means and methods.

    d. Requests for coordination information already indicated in the Contract Documents.

    e. Requests for adjustments in the Contract Time or the Contract Sum.

    f. Requests for interpretation of Owner's actions on submittals.

    g. Incomplete RFIs or inaccurately prepared RFIs.

2. Owner's action may include a request for additional information, in which case Owner's time for response will date from time of receipt of additional information.

3. Owner's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Section 01 26 00 - Contract Modification Procedures.

    a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Owner in writing within 10 days of receipt of the RFI response.

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

1. Project name.

2. Name and address of Contractor.

3. Name and address of Owner.

4. RFI number including RFIs that were returned without action or withdrawn.

5. RFI description.

6. Date the RFI was submitted.

7. Date Owner's response was received.

C. On receipt of Owner's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Owner within seven days if Contractor disagrees with response.

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

1.7 PROJECT MEETINGS

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

1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner of scheduled meeting dates and times.

2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.

3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner, within three days of the meeting.

B. Preconstruction Conference: Schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner, but no later than 15 days after execution of the Agreement.

1. Conduct the conference to review responsibilities and personnel assignments.

2. Attendees: Authorized representatives of Owner and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.

3. Agenda: Discuss items of significance that could affect progress, including the following:

b. Tentative construction schedule.

c. Phasing.

d. Critical work sequencing and long-lead items.

e. Designation of key personnel and their duties.

f. Lines of communications.

g. Procedures for processing field decisions and Change Orders.

h. Procedures for RFIs.

i. Procedures for testing and inspecting.

j. Procedures for processing Applications for Payment.

k. Distribution of the Contract Documents.

l. Submittal procedures.

m. Preparation of record documents.

n. Use of the premises.

o. Work restrictions.

p. Working hours.

q. Responsibility for temporary facilities and controls.

r. Procedures for disruptions and shutdowns.

s. Parking availability.

t. Office, work, and storage areas.

u. Equipment deliveries and priorities.

v. Safety requirements.

w. First aid.

x. Security.

y. Labor laws.

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

C. Pre-installation Conferences: Conduct a pre-installation conference at Project site before each construction activity that requires coordination with other construction.

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

2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:

    a. Contract Documents.

    b. Options.

    c. Related RFIs.

    d. Related Change Orders.

    e. Purchases.

    f. Deliveries.

    g. Submittals.

    h. Sustainable design requirements.

    i. Review of mockups.

    j. Possible conflicts.

    k. Compatibility requirements.

    l. Time schedules.

    m. Weather limitations.

    n. Manufacturer's written instructions.

    o. Warranty requirements.

    p. Compatibility of materials.

    q. Acceptability of substrates.

    r. Temporary facilities and controls.

    s. Space and access limitations.

    t. Regulations of authorities having jurisdiction.

    u. Testing and inspecting requirements.

    v. Installation procedures.

    w. Coordination with other work.

    x. Required performance results.

    y. Protection of adjacent work.

    z. Protection of construction and personnel.

3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.

4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.

5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.

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

1. Conduct the conference to review requirements and responsibilities related to Project closeout.

2. Attendees: Authorized representatives of Owner and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.

3. Agenda: Discuss items of significance that could affect or delay Project closeout, including the following:

a. Preparation of record documents.

b. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance.

c. Submittal of written warranties.

d. Requirements for completing sustainable design documentation.

e. Requirements for preparing operations and maintenance data.

f. Requirements for delivery of material samples, attic stock, and spare parts.

g. Requirements for demonstration

h. Safety and training.

i. Preparation of Contractor's punch list.

j. Procedures for processing Applications for Payment at Substantial Completion and for final payment.

k. Submittal procedures.

l. Coordination of separate contracts.

m. Owner’s partial occupancy requirements.

n. Installation of Owner’s furniture, fixtures, and equipment.

o. Responsibility for removing temporary facilities and controls.

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

E. Progress Meetings: Conduct progress meetings at biweekly intervals.

1. Coordinate dates of meetings with preparation of payment requests.

2. Attendees: In addition to representatives of Owner, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.

3. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.

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

1) Review schedule for next period.

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

1) Interface requirements.

2) Sequence of operations.

3) Status of submittals.

4) Deliveries.

5) Off-site fabrication.

6) Access.

7) Site utilization.

8) Temporary facilities and controls.

9) Progress cleaning.

10) Quality and work standards.

11) Status of correction of deficient items.

12) Field observations.

13) Status of RFIs.

14) Status of proposal requests.

15) Pending changes.

16) Status of Change Orders.

17) Pending claims and disputes.

18) Documentation of information for payment requests.

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

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

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

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SECTION 01 32 00 - CONSTRUCTION PROGRESS DOCUMENTATION

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

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

B. Related Requirements:

1. Section 01 33 00 - Contractor Submittals for submitting schedules and reports.
2. Section 01 40 00 - Quality Requirements for submitting a schedule of tests and inspections.

1.3 DEFINITIONS

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

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

1.4 INFORMATIONAL SUBMITTALS

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

1. Working electronic copy of schedule file, where indicated.

2. PDF electronic file.

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

C. Construction Schedule Updating Reports: Submit with Applications for Payment.

D. Daily Construction Reports: Submit at monthly intervals.

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

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

G. Qualification Data: For scheduling consultant.

1.5 COORDINATION

A. Coordinate Contractor's construction schedule with the schedule of values, submittal schedule, progress reports, payment requests, and other required schedules and reports.

1. Secure time commitments for performing critical elements of the Work from entities involved.

2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

PART 2 -- PRODUCTS

2.1 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

A. Time Frame: Extend schedule from date established for commencement of the Work to date of final completion.

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

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

1. Startup and Testing Time: Include no fewer than 15 days for startup and testing.

2. Substantial Completion: Indicate completion in advance of date established for Substantial Completion and allow time for Owner’s administrative procedures necessary for certification of Substantial Completion.

3. Punch List and Final Completion: Include not more than 30 days for completion of punch list items and final completion.

4. Indicate long-lead items that can disrupt major portions of work if not ordered in time.

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

D. Computer Scheduling Software: Prepare schedules using current version of a program that has been developed specifically to manage construction schedules.

2.2 REPORTS

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

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

B. Site Condition Reports: Immediately on discovery of a difference between site conditions and the Contract Documents, prepare and submit a detailed report. Submit with a Request for Information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

2.3 SPECIAL REPORTS

A. General: Submit special reports directly to Owner within one day of an occurrence. Distribute copies of report to parties affected by the occurrence.

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

PART 3 -- EXECUTION

3.1 CONTRACTOR'S CONSTRUCTION SCHEDULE

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

1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.

2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.

3. As the Work progresses, indicate final completion percentage for each activity.

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

END OF SECTION

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SECTION 01 33 00 – CONTRACTOR SUBMITTALS

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.

B. Related Requirements:

1. Section 01 29 00 - Payment Procedures for submitting Applications for Payment and the schedule of values.

2. Section 01 32 00 - Construction Progress Documentation for submitting schedules and reports, including Contractor's construction schedule.

3. Section 01 78 39 - Project Record Documents for submitting record Drawings, record Specifications, and record Product Data.

1.3 DEFINITIONS

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

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

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

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

1.4 ACTION SUBMITTALS

A. Submittal Schedule: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Owner and additional time for handling and reviewing submittals required by those corrections.

1. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Contractor's construction schedule.

2. Initial Submittal: Submit concurrently with startup construction schedule. Include submittals required during the first 60 days of construction. List those submittals required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.

3. Final Submittal: Submit concurrently with the first complete submittal of Contractor's construction schedule.

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

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

    a. Scheduled date for first submittal.

    b. Specification Section number and title.

    c. Submittal category: Action; informational.

    d. Name of subcontractor.

    e. Description of the Work covered.

    f. Scheduled date for Owner’s final release or approval.

    g. Scheduled date of fabrication.

    h. Scheduled dates for purchasing.

    i. Scheduled dates for installation.

    j. Activity or event number.

1.5 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

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

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

    a. Owner makes no representations as to the accuracy or completeness of digital data drawing files as they relate to the Contract Drawings.

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

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

2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.

3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.

4. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.

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

C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Owner's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.

2. Initial Review: Allow 10 working days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Owner will advise Contractor when a submittal being processed must be delayed for coordination.

3. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.

4. Resubmittal Review: Allow 10 working days for review of each resubmittal.

5. Sequential Review: Where sequential review of submittals by Owner's consultants, Owner, or other parties is indicated, allow 15 working days for initial review of each submittal.

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

1. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.

2. Name file with submittal number or other unique identifier, including revision identifier.

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

4. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by Owner.

5. Transmittal Form for Electronic Submittals: Use electronic form acceptable to Owner, containing the following information:

    a. Project name.

    b. Date.

c. Name and address of Owner.

d. Name of Construction Manager.

e. Name of Contractor.

f. Name of firm or entity that prepared submittal.

g. Names of subcontractor, manufacturer, and supplier.

h. Category and type of submittal.

i. Submittal purpose and description.

j. Specification Section number and title.

k. Specification paragraph number or drawing designation and generic name for each of multiple items.

l. Drawing number and detail references, as appropriate.

m. Location(s) where product is to be installed, as appropriate.

n. Related physical samples submitted directly.

o. Indication of full or partial submittal.

p. Transmittal number - numbered consecutively.

q. Submittal and transmittal distribution record.

r. Other necessary identification.

s. Remarks.

D. Options: Identify options requiring selection by Owner.

E. Deviations and Additional Information: On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Owner on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same identification information as related submittal. Ensure the Owner is included on all deviation requests. This is to ensure that the contract is not substantially changed.

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

1. Note date and content of previous submittal.

2. Note date and content of revision in label or title block and clearly indicate extent of revision.

3. Resubmit submittals until they are marked as either “No Exceptions Taken” or “Make Corrections Noted” from Owner’s action stamp. The Contractor shall not proceed with construction of submitted items until marked as either “No Exceptions Taken” or “Make Corrections Noted”.

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

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

PART 2 -- PRODUCTS

2.1 SUBMITTAL PROCEDURES

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

1. Submit electronic submittals via FTP or Engineer/Owner hosted sharepoint site as PDF electronic files.

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

2. Certificates and Certifications Submittals: Provide a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.

    a. Provide a notarized statement on original paper copy certificates and certifications where indicated.

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

1. If information must be specially prepared for submittal because standard published data are not suitable for use, submit as Shop Drawings, not as Product Data.

2. Mark each copy of each submittal to show which products and options are applicable.

3. Include the following information, as applicable:

    a. Manufacturer's catalog cuts.

    b. Manufacturer's product specifications.

    c. Standard color charts.

    d. Statement of compliance with specified referenced standards.

    e. Testing by recognized testing agency.

    f. Application of testing agency labels and seals.

    g. Notation of coordination requirements.

    h. Availability and delivery time information.

4. Submit Product Data before or concurrent with Samples.

5. Submit Product Data in the following format:

    a. PDF electronic file.

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

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

    a. Identification of products.

    b. Schedules.

    c. Compliance with specified standards.

    d. Notation of coordination requirements.

    e. Notation of dimensions established by field measurement.

    f. Relationship and attachment to adjoining construction clearly indicated.

    g. Seal and signature of professional engineer if specified.

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

3. Submit Shop Drawings in the following format:

    a. PDF electronic file.

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

1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.

2. Identification: Attach label on unexposed side of Samples that includes the following:

    a. Generic description of Sample.

    b. Product name and name of manufacturer.

    c. Sample source.

    d. Number and title of applicable Specification Section.

    e. Specification paragraph number and generic name of each item.

3. For projects where electronic submittals are required, provide corresponding electronic submittal of Sample transmittal, digital image file illustrating Sample characteristics, and identification information for record.

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

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

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

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

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

H. Closeout Submittals and Maintenance Material Submittals: Comply with requirements specified in Section 01 77 00 - Closeout Procedures.

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

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

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

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

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

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

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

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

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

1. Name of evaluation organization.

2. Date of evaluation.

3. Time period when report is in effect.

4. Product and manufacturers' names.

5. Description of product.

6. Test procedures and results.

7. Limitations of use.

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

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

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

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

2.2 DELEGATED-DESIGN SERVICES

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

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

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

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

PART 3 -- EXECUTION

3.1 CONTRACTOR'S REVIEW

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

D. Project Closeout and Maintenance Material Submittals: See requirements in Section 01 77 00 - Closeout Procedures.

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

3.2 OWNER'S ACTION

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

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

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

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

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

END OF SECTION

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SECTION 01 33 17 – STRUCTURAL DESIGN, SUPPORT AND ANCHORAGE

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall provide calculations and details for structural and non-structural components, supports, and anchorages as required by the Contract Documents and the 2021 IBC. The contractor shall furnish and install all such structural and non-structural components, supports, and anchorages in accordance with the calculations and details.

B. The Contractor shall provide calculations and details for structures and non-building structures, supports, and anchorages as required by the Contract Documents and the 2021 IBC. The contractor shall furnish and install all such structures and non-building structures, supports, and anchorages in accordance with the calculations and details.

C. Where a conflict exists between the requirements of the Contract Documents and the 2021 IBC, the more stringent requirement shall apply.

D. Design parameters used to determine Seismic and Wind design forces shall be as listed herein.

1.2 REFERENCES

A. IBC 2021 International Building Code

B. ASCE 7 American Society of Civil Engineers Standard 7-16 – Minimum Design Loads for Buildings and Other Structures.

C. ACI 318 Building Code Requirements for Structural Concrete (2022 edition)

D. ACI 530 Building Code Requirements and Specification for Masonry Structures (2022 edition)

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals.

B. Calculations and Details

1. Calculations and details are considered a Deferred Submittal as defined in the IBC.

2. Calculations and details shall be complete, accurate, and in accordance with the requirements of the IBC and ASCE 7, and shall be signed and sealed by a Structural Engineer registered in the State of Washington.

3. Calculations shall be clear and concise and show equipment and other non-structural component anchorage forces and the capacities of the anchorage elements proposed by the Contractor. The calculations shall substantiate a complete load path from the component or equipment being anchored into the supporting structure or foundation.

4. The calculations and details shall demonstrate a complete lateral and vertical load path, and shall clearly indicate all forces imposed on the supporting structure.

5. Calculations and details are required for all Non-Structural components, supports, anchorages, and attachments.

    a. Non-Structural components shall include all architectural, mechanical, and electrical components, equipment, piping, ductwork, and all other similar or related appurtenances necessary to produce the complete architectural, mechanical, and electrical systems.

6. When the Contract Documents require the Contractor to design structures or structural components, calculations and details for those structures and structural components, and their supports, anchorages, and attachments, are required.

7. When computer generated calculations and analyses are included as part (or as the whole) of the calculations, the calculations shall include, but not be limited to, the following: derivations of all input parameters; clear indication of the applicable load combinations and building code equations; diagrams of all members, geometry, support conditions, loads, forces, reactions and deflections, for all components and connections; and output results demonstrating all stress, force, deflection, and other Contract Document and building code requirements have been satisfied.

8. All calculations associated with anchorage into concrete or masonry shall be done using Strength Level forces, and shall be in accordance with the applicable provisions of ACI 318 and ACI 530, respectively.

9. Refer to Part 2 below for additional requirements.

1.4 SEISMIC DESIGN CRITERIA

A. Design Requirements

1. Design Parameters:

    a. Risk Category: II.

    b. Seismic Design Category: D.

    c. Site Class: D.

    d. Design spectral acceleration at short period: S_{DS} = 0.82.

    e. Design spectral acceleration at 1-second period: S_{D1} = 0.536

    f. Response modification coefficient, R: In accordance with ASCE 7, Tables 12.2-1, 12.14-1, 15.4-1 and 15.4-2.

    g. Seismic Importance Factor, I: 1.00

    h. Component amplification factor, a_p: In accordance with ASCE 7, Tables 13.5-1 and 13.6-1.

i. Component response modification factor, R_p: In accordance with ASCE 7, Tables 13.5-1 and 13.6-1.

2. The following components are exempted from the seismic design requirements:

a. Exemptions shall be as indicated in ASCE 7 Chapter 13.

1.5 WIND DESIGN CRITERIA

A. Design Requirements

1. Design Parameters:

a. Risk Category: II.

b. Basic 3-second Wind Gust Speed: 98 miles per hour.

c. Exposure Category: C.

d. Topographic Factor, K_{zt}: 1.0

PART 2 -- PRODUCTS

2.1 GENERAL

A. Non-Structural Component Supports and Anchors

1. Unless otherwise indicated, non-structural component supports, anchors, and restrainers shall be adequately designed for all applicable static, dynamic, operational, seismic, and wind loads.

a. Wall-mounted equipment weighing more than 250 lbs. or which is within 18-inches of the floor shall be provided with fabricated steel supports. Pedestals shall be of welded steel or engineered framing support systems. If the supported equipment is a panel or cabinet or is enclosed with removable sides, the pedestal shall match the supported equipment in appearance and dimensions.

b. All equipment and all other non-structural components shall be supported and anchored in place by methods that satisfy the building code and the Contract Documents.

c. All equipment and all other non-structural components shall be supported and anchored in place by methods that satisfy the manufacturer's applicable seismic certification requirements.

2. Component attachments shall be bolted, welded, or otherwise positively fastened without consideration of frictional resistance produced by the effects of gravity.

3. Friction shall not be used to resist sliding due to seismic forces, except as indicated below:

B. Anchors – General

1. Anchor bolts shall be in accordance with Section 05 05 19 and Section 05 50 00.

2. Grouts for anchor bolts shall be in accordance with Section 03 60 00.

3. The Contractor shall determine the size, type, capacity, location, and other placement requirements of anchorage elements. Anchoring methods and leveling criteria in the manufacturer's literature shall be followed. Submit methods and criteria with the calculations and details.

4. Anchor bolt calculations shall clearly show that the capacity of the anchor and the capacity of the concrete that the anchor is embedded in are adequate to resist all applicable load combinations, including seismic and wind loads.

   a. The design of anchors resisting seismic forces shall satisfy the ductility requirements stated in the IBC, ASCE 7, ACI 318, and ACI 530.

5. Reduction factors associated with edge distance, embed length, grout and base plate thickness, and bolt spacing shall all be considered and based on the actual dimensions of the concrete or masonry that resists the anchorage forces.

6. Where anchorage is required into or through equipment pads, the following requirements shall apply unless otherwise approved by the Engineer:

   a. For tensile forces, the embed length and associated concrete failure zone shall be provided entirely within the structural slab. No portion of the equipment pad may be considered as effective in resisting tensile forces.

   b. For shear forces, the edge distance and associated concrete failure zone shall be provided entirely within the equipment pad. No portion of the structural slab may be considered as effective in resisting shear forces.

7. Anchor bolt details shall include required bolt diameter, embed, spacing, and edge distances.

8. Where additional reinforcement is required to satisfy anchorage requirements, such reinforcement shall be included in the anchorage details, and shall be furnished and installed by the Contractor.

C. Mechanical and Electrical Equipment Foundations

1. Equipment foundations are indicated on Drawings. The Contractor, through the equipment manufacturer, shall verify the size and weight of the equipment foundation to ensure compatibility with equipment.

2. Equipment foundation dimensions shall be coordinated with the equipment base geometry and the edge distance and embed requirements of the equipment anchorage calculations.

D. Mechanical and Electrical Equipment (Housekeeping) Pads

1. General

    a. Equipment, tanks, control cabinets, enclosures, and related equipment shall be mounted on concrete equipment pads, unless otherwise indicated. The top surface of the equipment pads shall be level, unless otherwise indicated, or otherwise required by the equipment manufacturer.

    b. Equipment pads shall be sized to accommodate the bearing and anchorage requirements of the equipment, subject to the constraints listed below.

    c. Final geometry of the equipment pads shall not result in a condition that violates applicable building code provisions, including but not limited to the provisions of the National Electric Code.

2. Mechanical Equipment Pads

    a. Mechanical equipment pad heights shall be coordinated with process equipment and piping elevation requirements. Where no such elevation constraints exist, the equipment pad height shall be as shown on the drawings, or as indicated below when no specific height is provided.

        1) Equipment pads for mechanical equipment shall be 3.5 inches tall (maximum) at the front of the equipment.

    b. Mechanical equipment pads shall extend not more than 2 inches beyond the front, back, and sides of the equipment, except as indicated below, unless otherwise shown on the drawings.

        1) Where necessary to meet seismic or wind anchorage requirements, the pads may be extended beyond the 2 inch limit indicated above. The pads shall extend not more than 6 inches beyond the front, back, and sides of the equipment.

3. Electrical Equipment Pads

    a. Electrical equipment pads shall be 3.5 inches tall (maximum) at the front of the equipment.

    b. Electrical equipment pads shall extend not more than 2 inches beyond the front, back, and sides of the equipment, except as indicated below, unless otherwise shown on the drawings.

        1) Where necessary to meet seismic anchorage requirements, the pads may be extended beyond the 2 inch limit indicated above. The pads shall extend not more than 6 inches beyond the front, back, and sides of the equipment.

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

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SECTION 01 40 00 – QUALITY REQUIREMENTS

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 administrative and procedural requirements for quality assurance and quality control.

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

1. Specific quality-assurance and -control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.

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

3. Requirements for Contractor to provide quality-assurance and -control services required by Owner or authorities having jurisdiction are not limited by provisions of this Section.

4. Specific test and inspection requirements are not specified in this Section.

1.3 DEFINITIONS

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

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

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

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

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

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

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

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

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

1.4 CONFLICTING REQUIREMENTS

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

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

1.5 INFORMATIONAL SUBMITTALS

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

1.6 REPORTS AND DOCUMENTS

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

1. Date of issue.

2. Project title and number.

3. Name, address, and telephone number of testing agency.

4. Dates and locations of samples and tests or inspections.

5. Names of individuals making tests and inspections.

6. Description of the Work and test and inspection method.

7. Identification of product and Specification Section.

8. Complete test or inspection data.

9. Test and inspection results and an interpretation of test results.

10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.

11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.

12. Name and signature of laboratory inspector.

13. Recommendations on retesting and reinspecting.

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

1. Name, address, and telephone number of technical representative making report.

2. Statement on condition of substrates and their acceptability for installation of product.

3. Statement that products at Project site comply with requirements.

4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.

5. Results of operational and other tests and a statement of whether observed performance complies with requirements.

6. Statement whether conditions, products, and installation will affect warranty.

7. Other required items indicated in individual Specification Sections.

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

1. Name, address, and telephone number of factory-authorized service representative making report.

2. Statement that equipment complies with requirements.

3. Results of operational and other tests and a statement of whether observed performance complies with requirements.

4. Statement whether conditions, products, and installation will affect warranty.

5. Other required items indicated in individual Specification Sections.

D. Permits, Licenses, and Certificates: For Owner’s records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices,

receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

1.7 QUALITY ASSURANCE

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

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

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

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

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

F. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated, as documented according to ASTM E 329; and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.

1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.

2. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.

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

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

I. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:

1. Contractor responsibilities include the following:

    a. Provide test specimens representative of proposed products and construction.

    b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.

    c. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.

    d. Build site-assembled test assemblies and mockups using installers who will perform same tasks for Project.

    e. Build laboratory mockups at testing facility using personnel, products, and methods of construction indicated for the completed Work.

    f. When testing is complete, remove test specimens, and assemblies; do not reuse products on Project. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Engineer, with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.

1.8 QUALITY CONTROL

A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.

    1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspecting they are engaged to perform.

    2. Costs for retesting and re-inspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor.

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

    1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.

    2. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.

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

    4. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.

5. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.

6. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.

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

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

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

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

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

1. Access to the Work.

2. Incidental labor and facilities necessary to facilitate tests and inspections.

3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.

4. Facilities for storage and field curing of test samples.

5. Preliminary design mix proposed for use for material mixes that require control by testing agency.

6. Security and protection for samples and for testing and inspecting equipment at Project site.

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

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

1.9 SPECIAL TESTS AND INSPECTIONS

A. Special Tests and Inspections: Conducted by a qualified testing agency as required by authorities having jurisdiction, as indicated in individual Specification Sections.

1. Notifying Engineer and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.

2. Submitting a certified written report of each test, inspection, and similar quality-control service to Engineer with copy to Contractor and to authorities having jurisdiction.

3. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.

4. Interpreting tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.

5. Retesting and re-inspecting corrected work.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION

3.1 TEST AND INSPECTION LOG

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

B. Date test or inspection was conducted.

C. Description of the Work tested or inspected.

1. Date test or inspection results were transmitted to Engineer.

2. Identification of testing agency or special inspector conducting test or inspection.

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

3.2 REPAIR AND PROTECTION

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

1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 01 73 00 - Execution.

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

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

END OF SECTION

SECTION 01 41 60 - SPECIAL INSPECTIONS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The Contractor shall cooperate with the Owner and Engineer in performing Special Inspections of the Work.

1.2 SCHEDULE OF INSPECTIONS/OBSERVATIONS

A. Special Inspections and tests and Structural Observations are listed on sheets GS-1 and GS-2 of the Contract Drawings. Certain individual specification sections may contain Special Inspections and tests specific to those sections.

1.3 DEFINITIONS

A. Approved Agency: An established and recognized agency regularly engaged in conducting tests or furnishing inspection services, when such agency has been approved by the Building Official.

B. Approved Fabricator: An established and qualified person, firm, or corporation identified as such by the Building Official. Approval is based on written procedural and quality control manuals and periodic auditing of fabrication practices by an Approved Agency.

C. Building Official: Local department or its representatives responsible for enforcing local codes, reviewing construction documents, and issuing permits for the erection, alteration, demolition, and moving of buildings and structures.

D. Continuous Special Inspection: The full-time observation of Work by a Special Inspector who is present in the area where the Work is being performed as it is performed.

E. Fabricated Item: Structural, load-bearing, or lateral load-resisting assemblies consisting of materials assembled prior to installation in a building or structure, or subjected to operations such as heat treatment, thermal cutting, cold working, or reforming after manufacture and prior to installation in the building or structure. Materials produced in accordance with standard specifications referenced in the Contract Documents or the Code, such as rolled structural steel shapes, steel-reinforcing bars, masonry units, and plywood sheets are not Fabricated Items.

F. Periodic Special Inspection: The part-time or intermittent observation of Work by a Special Inspector who is present in the area where the Work has been or is being performed and at the completion of the Work.

G. Special Inspection: Inspection as herein required of the materials, installation, fabrication, erection or placement of components and connections requiring special expertise to ensure compliance with the Contract Documents and referenced standards. Special Inspection does not include, waive, or otherwise affect the Contractor 's responsibility for inspections required by the Contract Documents.

H. Special Inspector: An individual employed by an Approved Agency who is regularly engaged in conducting tests and furnishing Special Inspection services. The Special Inspector is an agent of the Engineer and is responsible to the Engineer. The Special Inspector will be approved and registered by the local Building Official.

I. Structural Observer: Registered design professional and agent of the Engineer, who provides Structural Observation services during construction.

J. Structural Observation: Visual observation by a Structural Observer of the structural system for general conformance to the Contract Documents at significant construction stages and at completion of the structural system. Structural observation does not include, waive, or otherwise affect the Contractor's responsibility for inspections required by the Contract Documents.

1.4 SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals.

B. The Contractor and Subcontractors whose Work will be inspected or tested shall disclose any past or present business relationship or potential conflict of interest with the Special Inspector, Testing Laboratory, and Structural Observer.

C. When fabrication of assemblies that would otherwise require Special Inspection is done on an Approved Fabricator's premises, the following shall be submitted:

1. At completion of fabrication, the Approved Fabricator shall submit to the Engineer and the Building Official a certificate of compliance stating that the Work was performed in accordance with the Contract Documents.

D. Contractor’s Statement of Responsibility: The Contractor shall submit to the Building Official and to the Engineer a written Contractor’s Statement of Responsibility prior to commencing Work on any system designated a main Wind and/or Seismic resisting system and any Wind and/or Seismic resisting component as listed in the statement of special inspections. The Contractor’s Statement of Responsibility shall contain the following:

1. Acknowledgment of awareness of the special requirements contained in the statement of special inspection for Seismic Resistance.

2. Acknowledgment that control will be exercised to obtain conformance with the Contract Documents.

3. Procedures for exercising control within the Contractor’s organization, the method and frequency of reporting, and the distribution of reports.

4. Identification and qualifications of the persons exercising such control and their positions in the organization.

1.5 CONTRACTOR RESPONSIBILITIES

A. In performing the Work, the Contractor shall cooperate with the Special Inspector and the Structural Observer, so that the Special Inspections, Structural Observations, and testing may be performed without hindrance.

B. The Contractor shall review Special Inspections and Structural Observations on drawings GS-1 and GS-2 and individual specification sections and shall be responsible for coordinating and scheduling inspections, observations, and tests. The Contractor shall notify the Engineer at least 48 hours in advance of a required Special Inspection, Structural Observation, or test.

C. If any Work that is to receive any Special Inspection, test, or Structural Observation is covered without concurrence in writing from the Engineer, it shall be uncovered at the Contractor 's expense unless the Contractor has given the notice required above and the Special Inspector, testing laboratory, or Structural Observer has not acted with reasonable promptness to such notice. Removal and replacement of any finished Work damaged by the uncovering process or as required for corrective action shall be at the Contractor's expense.

D. The Contractor shall furnish incidental labor and facilities for access to the Work to be inspected, observed, or tested, shall obtain and handle samples at the Site or at the source of products to be tested, and shall facilitate tests, observations, inspections, storage, and curing of test samples.

E. The Contractor shall keep at the Site the latest set of Contract Drawings, field sketches, change orders, approved submittals, and specifications for use by the Special Inspector and Structural Observer.

F. The Special Inspection and observation program shall in no way relieve the Contractor of this obligation to perform Work in accordance with the requirements of the Contract Documents or from implementing an effective Quality Control program. The Contractor's quality control personnel shall first review all Work that is to be subjected to Special Inspection or Structural Observation.

G. Prior to the beginning of construction, the Contractor shall have a pre-construction meeting with the Engineer, Building Official, Owner, Special Inspector, Structural Observer, and Testing Laboratories, to review the Special Inspection and Structural Observation requirements.

H. The Owner will engage and pay for the services of the Special Inspector, Testing Laboratory, and Structural Observer.

I. If any materials that require Special Inspections are fabricated in a plant further than 100 miles from the Site, the Contractor shall pay for travel expenses of the Special Inspector and Testing Laboratory.

J. The Contractor shall be responsible for the Special Inspection cost of any replacement and re-testing or re-inspection of Work that is determined to be Defective Work.

1.6 INSPECTION OF FABRICATIONS

A. When Work is performed on the premises of an Approved Fabricator, no Special Inspection is required.

1.7 RECORDS AND REPORTS

A. The Special Inspector will prepare detailed daily reports of each Special Inspection or test.

B. The Structural Observer will prepare detailed reports of each structural observation.

C. Any deviations from the Contract Documents found during a Special Inspection or Structural Observation will be immediately reported to the Contractor. If the discrepancies are not corrected promptly, the Special Inspector or Structural Observer will notify the Engineer and Building Official. Daily reports will identify all discrepancies and the corrective actions taken.

1.8 FINAL REPORTS OF SPECIAL INSPECTIONS AND STRUCTURAL OBSERVATIONS

1. The Final Report of Special Inspections, completed by the Special Inspector, will be submitted to the Engineer and Building Official prior to issuance of a Certificate of Use and Occupancy.

2. The Final Report of Special Inspections will certify that required inspections have been performed and will itemize any deviations that were not corrected or resolved.

3. The Final Structural Observation Report will certify that Site visits have been made and identify any deviations, which, to the best of the Structural Observer's knowledge, have not been corrected or resolved.

1.9 STATEMENT OF SPECIAL INSPECTION FOR SEISMIC RESISTANCE

A. The following systems are subject to quality assurance for seismic resistance. The Seismic Design Category for each structure is shown on the structural drawings.

1. Seismic Force Resisting Systems in Seismic Design Categories C, D, E, or F.

2. Designated Structural Systems in Seismic Design Category D, E, or F:

1.10 STATEMENT OF SPECIAL INSPECTION FOR WIND REQUIREMENTS

A. The following systems are subject to quality assurance for wind requirements.

1. Roof cladding and roof framing connections

2. Wall connections to roof and framing

3. Roof and floor diaphragm systems, including collectors, drag struts, and boundary elements.

4. Vertical wind force-resisting systems, including braced frames, moment frames, and shear walls.

5. Wind force-resisting systems connections to the foundations.

6. Fabrication and installation of components and assemblies specifically indicated to be impact resistant.

PART 2 -- (NOT USED)

PART 3 -- EXECUTION

3.1 STAFFING

A. The following firms are intended to be retained to perform the special inspections and Structural Observations required in the Contract Documents:

1. Special Inspector – To be determined by mutual agreement of Contractor and Owner.

2. Testing Laboratory - To be determined by mutual agreement of Contractor and Owner.

3. Structural Observation - To be determined by mutual agreement of Contractor and Owner.

END OF SECTION

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SECTION 01 50 00 – TEMPORARY FACILITIES AND CONTROLS

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 temporary utilities, support facilities, and security and protection facilities.

B. Related Requirements:

1. Section 01 10 00 - Summary for work restrictions and limitations on utility interruptions.

1.3 USE CHARGES

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

A. Water Service: Contractor shall obtain a temporary water service from Tulalip Utility Authority.

B. Electric Power Service: Contractor shall obtain a temporary electric power service drop from Snohomish Public Utility District (SNOPUD).

1.4 INFORMATIONAL SUBMITTALS

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

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

C. Temporary Storage for Equipment: Provide photos and a description of the storage location for equipment to be installed during the project. Location must be in accordance with manufacturer's requirements to maintain warranty.

1.5 QUALITY ASSURANCE

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

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

1.6 PROJECT CONDITIONS

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

1.7 STORAGE

A. During the interval between the delivery of equipment to the site and installation, all equipment, unless otherwise specified, shall be stored in an enclosed space affording protection from theft, vandalism, weather, dust, and mechanical damage and providing favorable temperature, humidity and ventilation conditions to ensure against equipment deterioration. The building may be a temporary structure on or off-site, as accepted by the Project Representative. Maintain temperature and humidity in the building within the range required by equipment manufacturer and supported and oriented in accordance with the manufacturer's written requirements.

B. Equipment and materials to be located outdoors may be stored outdoors if protected from theft, vandalism, and against moisture condensation and supported and oriented in accordance with the manufacturer's written requirements. Equipment shall be stored at least 6 inches above ground. Temporary power shall be provided to energize space heaters or other heat sources for control of moisture condensation. Space heaters or other heat sources shall be energized without disturbing the sealed enclosure.

C. All equipment: stored fully lubricated with oil, grease and other lubricants unless otherwise instructed by the manufacturer.

D. Moving parts: rotated a minimum of once weekly to ensure proper lubrication and to avoid metal-to-metal galling or "welding".

PART 2 -- PRODUCTS

2.1 MATERIALS

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

B. Portable Chain-Link Fencing: Minimum 2-inch, 0.148-inch-thick, galvanized-steel, chain-link fabric fencing; minimum 6 feet high with galvanized-steel pipe posts; minimum 2-3/8-inch-OD line posts and 2-7/8-inch-OD corner and pull posts, with 1-5/8-inch-OD top and bottom rails. Provide galvanized-steel bases for supporting posts.

PART 3 -- EXECUTION

3.1 INSTALLATION, GENERAL

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

1. Locate facilities to limit site disturbance as specified in Section 01 10 00 - Summary.

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

3.2 TEMPORARY UTILITY INSTALLATION

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

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

B. Water Service: Tulalip Utility Authority fire hydrant access and meter.

C. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities if utilizing the Tulalip Utility Authority sanitary sewer system.

D. Electric Power Service: Temporary service drop and meter from SNOPUD.

3.3 SUPPORT FACILITIES INSTALLATION

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

1. Protect existing site improvements to remain including curbs, pavement, and utilities.

2. Maintain access for fire-fighting equipment and access to fire hydrants.

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

C. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.

1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties or endanger permanent Work or temporary facilities.

D. Project Signs: Provide Project signs as indicated. Unauthorized signs are not permitted.

1. Identification Signs: Provide Project identification signs as indicated on Drawings.

2. Temporary Signs: Provide other signs as indicated and as required to inform public and individuals seeking entrance to Project.

a. Provide temporary, directional signs for construction personnel and visitors.

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

E. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction. Comply with progress cleaning requirements in Section 01 73 00 "Execution."

3.4 SECURITY AND PROTECTION FACILITIES INSTALLATION

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

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

B. Temporary Erosion and Sedimentation Control: Provide measures to prevent soil erosion and discharge of soil-bearing water runoff and airborne dust to undisturbed areas and to adjacent properties and walkways, according to requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent.

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

D. Tree and Plant Protection: Install temporary fencing located outside the drip line of trees to protect vegetation from damage from construction operations. Protect tree root systems from damage, flooding, and erosion.

E. Site Enclosure Fence: Prior to commencing earthwork, furnish and install site enclosure fence in a manner that will prevent people and animals from easily entering site except by entrance gates.

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

F. Security Lighting and Cameras: Contractor may consider security lighting and cameras to reduce the risk of theft and vandalism. Control lighting to reduce impacts to neighboring buildings.

G. Graffiti: Remove or paint-over graffiti within 24 hours of discovery on any structure or equipment on the site until Substantial Completion.

3.5 MOISTURE AND MOLD CONTROL

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

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

1. Protect porous materials from water damage.

2. Protect stored and installed material from flowing or standing water.

3. Keep porous and organic materials from coming into prolonged contact with concrete.

4. Remove standing water from decks.

5. Keep deck openings covered or dammed.

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

1. Do not load or install drywall or other porous materials or components, or items with high organic content, into partially enclosed building.

2. Keep interior spaces reasonably clean and protected from water damage.

3. Periodically collect and remove waste containing cellulose or other organic matter.

4. Discard or replace water-damaged material.

5. Do not install material that is wet.

6. Discard, replace, or clean stored or installed material that begins to grow mold.

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

C. Controlled Construction Phase of Construction: After completing and sealing of the building enclosure but prior to the full operation of permanent HVAC systems, maintain as follows:

1. Control moisture and humidity inside building by maintaining effective dry-in conditions.

2. Use permanent HVAC system to control humidity.

3. Comply with manufacturer's written instructions for temperature, relative humidity, and exposure to water limits.

a. Hygroscopic materials that may support mold growth, including wood and gypsum-based products, that become wet during the course of construction and remain wet for 48 hours are considered defective.

b. Measure moisture content of materials that have been exposed to moisture during construction operations or after installation. Record readings beginning at time of exposure and continuing daily for 48 hours. Identify materials containing moisture levels higher than allowed. Report findings in writing to Engineer.

c. Remove materials that cannot be completely restored to their manufactured moisture level within 48 hours.

END OF SECTION

SECTION 01 60 00 – PRODUCT REQUIREMENTS

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

B. Related Requirements:

1. Section 01 25 00 - Substitution Procedures for requests for substitutions.

1.3 DEFINITIONS

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

1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.

2. New Products: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.

3. Comparable Product: Product that is demonstrated and approved through submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.

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

1.4 ACTION SUBMITTALS

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

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

1. Owner's Action: If necessary, Owner will request additional information or documentation for evaluation within one week of receipt of a comparable product request. Owner will notify Contractor of approval or rejection of proposed comparable product request within 10 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.

a. Form of Approval: As specified in Section 01 33 00 - Contractor Submittals.

b. Use product specified if Owner does not issue a decision on use of a comparable product request within time allocated.

C. Basis-of-Design Product Specification Submittal: Comply with requirements in Section 01 33 00 - Contractor Submittals. Show compliance with requirements.

1.5 QUALITY ASSURANCE

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

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

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

B. Delivery and Handling:

1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.

2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.

3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.

4. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.

C. Storage:

1. Store products to allow for inspection and measurement of quantity or counting of units.

2. Store materials in a manner that will not endanger Project structure.

3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.

4. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.

5. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.

6. Protect stored products from damage and liquids from freezing.

1.7 PRODUCT WARRANTIES

A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.

1. Manufacturer's Warranty: Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.

2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner.

B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.

1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.

2. Specified Form: When specified forms are included with the Specifications, prepare a written document using indicated form properly executed.

3. See other Sections for specific content requirements and particular requirements for submitting special warranties.

C. Submittal Time: Comply with requirements in Section 01 77 00 - Closeout Procedures.

PART 2 -- PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

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

1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.

2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.

3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.

4. Where products are accompanied by the term "as selected," Owner will make selection.

5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.

B. Product Selection Procedures:

1. Products:

a. Nonrestricted List: Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed, or an unnamed product, that complies with requirements. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product.

2. Manufacturers:

a. Nonrestricted List: Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed, or a product by an unnamed manufacturer, that complies with requirements. Comply with requirements in "Comparable Products" Article for consideration of an unnamed manufacturer's product.

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

2.2 COMPARABLE PRODUCTS

A. Conditions for Consideration: Owner will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not

satisfied, Owner may return requests without action, except to record noncompliance with these requirements:

1. Evidence that the proposed product does not require revisions to the Contract Documents, that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.

2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.

3. Evidence that proposed product provides specified warranty.

4. List of similar installations for completed projects with project names and addresses and names and addresses of Owner, if requested.

5. Samples, if requested.

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

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SECTION 01 71 00 – MOBILIZATION

PART 1 - GENERAL

1.1 THE SUMMARY

A. CONTRACTOR shall mobilize as required for the proper performance and completion of the WORK and in accordance with the Contract Documents.

B. Mobilization shall include at least the following items:

1. Installing temporary construction power, wiring, and lighting facilities complying with Section 01 50 00 - Temporary Facilities and Controls.

2. Obtaining construction water supply.

3. Providing field offices for the CONTRACTOR, complete with furnishings, equipment, and utility services.

4. Providing on-Site communication facilities, including telephones and internet.

5. Providing on-Site sanitary facilities and potable water facilities.

6. Arranging for garbage collection and/or disposal service.

7. Arranging for and erection of CONTRACTOR's WORK and storage yards.

8. Constructing and implementing security features and requirements complying with Section 01 50 00 - Temporary Facilities and Controls.

9. Providing suitable storage location for sensitive equipment.

10. Having OSHA required notices and establishing safety programs.

11. Submitting initial submittals.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

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SECTION 01 73 00 – EXECUTION

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 general administrative and procedural requirements governing execution of the Work including, but not limited to, the following:

1. Construction layout.
2. Field engineering and surveying.
3. Installation of the Work.
4. Coordination of Owner-installed products.
5. Progress cleaning.
6. Starting and adjusting.
7. Protection of installed construction.

B. Related Requirements:

1. Section 01 10 00 - Summary for limits on use of Project site.
2. Section 01 33 00 - Contractor Submittals for submitting surveys.
3. Section 01 77 00 - Closeout Procedures for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, and final cleaning.

1.3 DEFINITIONS

A. Cutting: Removal of in-place construction necessary to permit installation or performance of other work.

B. Patching: Fitting and repair work required to restore construction to original conditions after installation of other work.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For land surveyor.

B. Landfill Receipts: Submit copy of receipts issued by a transfer station or landfill facility, licensed to accept hazardous materials, for hazardous waste disposal.

1.5 QUALITY ASSURANCE

A. Land Surveyor Qualifications: A professional land surveyor who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing land-surveying services of the kind indicated.

B. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of products and equipment.

PART 2 -- PRODUCTS

2.1 MATERIALS

A. General: Comply with requirements specified in other Sections.

1. For projects requiring compliance with sustainable design and construction practices and procedures, use products for patching that comply with sustainable design requirements.

PART 3 -- EXECUTION

3.1 EXAMINATION

A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities, and other construction affecting the Work.

B. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water-service piping as well as underground electrical services and other utilities.

1.Furnish location data for work related to Project that must be performed by public utilities serving Project site.

C. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.

D. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:

1. Description of the Work.

2. List of detrimental conditions, including substrates.

3. List of unacceptable installation tolerances.

4. Recommended corrections.

E. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Existing Utility Information: Furnish information to Owner that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.

B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.

D. Review of Contract Documents and Field Conditions: Immediately upon discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the control of Contractor, submit a request for information to Owner according to requirements in Section 01 31 00 "Project Management and Coordination."

3.3 CONSTRUCTION LAYOUT

A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, notify Owner promptly.

B. General: Engage a land surveyor to lay out the Work using accepted surveying practices.

1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.

2. Establish limits on use of Project site.

3. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.

4. Inform installers of lines and levels to which they must comply.

5. Check the location, level and plumb, of every major element as the Work progresses.

6. Notify Owner when deviations from required lines and levels exceed allowable tolerances.

7. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.

C. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and rim and invert elevations.

D. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Owner.

3.4 FIELD ENGINEERING

A. Identification: Owner will identify existing benchmarks, control points, and property corners.

B. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.

1. Do not change or relocate existing benchmarks or control points without prior written approval of Owner. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to Owner before proceeding.

2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.

C. Benchmarks: Establish and maintain a minimum of two permanent benchmarks on Project site, referenced to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark.

1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.

2. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Work.

3. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.

3.5 INSTALLATION

A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.

1. Make vertical work plumb and make horizontal work level, except pipes that are indicated to be sloped.

2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.

3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.

4. Maintain minimum headroom clearance of 96 inches in occupied spaces and 90 inches in unoccupied spaces. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.

B. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.

C. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.

D. Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.

E. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.

F. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.

G. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions.

1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Owner.

2. Allow for building movement, including thermal expansion and contraction.

3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

H. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.

I. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

3.6 PROGRESS CLEANING

A. General: Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.

1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.

2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F.

3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.

   a. Use containers intended for holding waste materials of type to be stored.

4. Coordinate progress cleaning for joint-use areas where Contractor and other contractors are working concurrently.

B. Site: Maintain Project site free of waste materials and debris.

C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.

1. Remove liquid spills promptly.

2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.

D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.

E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.

F. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. Comply with waste disposal requirements in Section 01 74 19 "Construction Waste Management and Disposal."

H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.

I. Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.7 STARTING AND ADJUSTING

A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.

B. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.

C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Manufacturer's Field Service: Comply with qualification requirements in Section 01 40 00 "Quality Requirements."

3.8 PROTECTION OF INSTALLED CONSTRUCTION

A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.

B. Comply with manufacturer's written instructions for temperature and relative humidity.

END OF SECTION

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SECTION 01 74 20 - GRAVITY PIPELINE TESTING

PART 1 - GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall test drain system pipelines, manholes, vaults, catchbasins and standpipes in accordance with the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Contractor Submittals.

B. Furnish:

1. A testing plan and schedule including methods for water conveyance, control, leak testing, and water disposal shall be submitted in writing for approval.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 GENERAL

A. Gravity pipes and laterals shall be tested for exfiltration or infiltration as indicated. Manholes, wet wells, and catchbasins shall be tested for leakage prior to backfill placement, whereas pipes shall be backfilled prior to testing. The maximum length of pipe tested shall be the 4 reaches between 5 manholes. Leakage tests shall be completed and approved prior to placing of permanent resurfacing of pavement. When leakage or infiltration exceeds the allowed amount, the CONTRACTOR shall locate the leaks and make the necessary repairs or replacements to reduce the leakage or infiltration to the allowable limits. Individually detectable leaks shall be repaired, regardless of whether the test results are acceptable or not.

B. Unless otherwise indicated, water for testing will be furnished by the Contractor.

C. No materials shall be used which would be injurious to pipeline structure and future function. Air test gauges shall be laboratory-calibrated test gauges, and if required by the ENGINEER, shall be recalibrated by a certified laboratory prior to the leakage test. Air test gauges shall have a size and pressure range appropriate for the pipe being tested.

D. Testing operations shall be performed in the presence of the ENGINEER.

3.2 TESTING SCHEDULE

A. Leakage Tests

1. Perform the type of leakage tests determined from the table below, based on pipe size, slope between manholes or structures (Criterion 1), and difference in water levels (Criterion 2).

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	Criterion 1		Criterion 2	
Nominal Pipe Size	**Manhole or Structure Delta H, feet**		**Test Water vs Ground Water Delta H, feet**	
	Less than or equal to10 ft	greater than 10 ft	greater than or equal to 4 ft	less than 4 ft
less than or equal to 24 inches	See Criterion 2	Infiltration or Air See Note 1	Exfiltration	Infiltration or Air
greater than 24 inches	See Criterion 2	See Criterion 2	Exfiltration	Infiltration

Note 1. If ground water is present, perform an infiltration test or air test at the option of the CONTRACTOR; if no ground water is present, perform an air test.

2. Definitions

a. Delta H is the difference between 2 elevations, expressed in feet.

b. Manhole Delta H is the invert elevation difference in 2 adjacent manholes.

c. Test Water vs Ground Water Delta H is the required elevation of water surface for testing minus the average elevation of ground water adjacent to the pipe to be tested. Units are feet.

3.3 WATER EXFILTRATION TEST

A. Each section of pipe shall be tested between by closing downstream end with stoppers or inflatable plugs. The pipe shall be filled with water to a point 4-feet above the highpoint of the pipe.

B. Water shall remain in the pipe for at least one hour or until the water level stabilizes, whichever is longer, before the test begins. The minimum test duration shall be 4 hours.

C. Unless indicated otherwise, the CONTRACTOR shall measure exfiltration. Measure the amount of water added to the upstream end of the pipe to maintain the water level at the elevation set above. Compare the amount added to the allowable leakage calculated below, and if the amount added is equal to or less than the allowable amount, the tested section of the pipe has passed.

D. The allowable leakage will be computed by the formula:

$$E = 0.000012\ LD\ (H)^{1/2}$$

Where:

E = Allowable leakage in gallons per minute of sewer tested.

L = Length of sewer and house connections tested, in feet.

D = Internal diameter of the pipe in inches.

H = Elevation difference in feet between the water surface in the upper manhole and the centerline of the pipe at the lower manhole; or if ground water is present above the centerline of the pipe in the lower manhole, the difference in elevation between the water surface in the upper manhole and the ground water at the lower manhole.

3.4 WATER INFILTRATION TEST

A. The end of the pipe at the upper structure shall be closed to prevent the entrance of water, and pumping of ground water shall be discontinued for at least 3 days, after which the section shall be tested for infiltration.

B. The infiltration into each individual reach of pipe between adjoining structures or manholes shall not exceed that allowed by the formula above, where H is the difference in the elevation between the ground water surface and the invert of the sewer at the downstream manhole.

C. Unless otherwise indicated, infiltration shall be measured by the CONTRACTOR.

3.5 AIR PRESSURE TEST

A. The CONTRACTOR shall furnish all materials, equipment, and labor for making an air test. Air test equipment shall be approved by the ENGINEER.

B. The CONTRACTOR may conduct an initial air test of the pipe after densification of the backfill but prior to installation of any laterals. Such tests will be considered to be for the CONTRACTOR's convenience and need not be performed in the presence of the ENGINEER.

C. Each section of pipe shall be tested between successive manholes by plugging and bracing all openings in the pipe and the upper ends of all laterals. Prior to insertion in the pipe, each plug shall be checked with a soap solution to detect any air leakage. If any leaks are found, the air pressure shall be released and the leaks eliminated or the plug replaced.

D. The test of the pipe and laterals shall be conducted in the presence of the ENGINEER. Testing of pipe, regardless of the pipe material, shall be performed in accordance with ASTM F 1417 - Standard Test Method for Installation of Plastic Gravity Sewer Line Using Low Pressure Air.

E. Air pressure shall be increased to 4.0 psi above groundwater pressure (1.0 psi for each 2.3 feet of water elevation above the highest point of the pipe). Do not allow the pressure at any point in the pipe to reach 9 psi under any circumstances. Allow the pressure to stabilize for 5 minutes, then reduce the pressure to 3.5 psi above groundwater pressure and start the test. Stop the air release and record the decrease in pressure over time.

F. Pass/Fail Criterion: The time taken for the pressure to decrease from 3.5 to 2.5 psi above groundwater pressure shall be equal to or greater than the time below.

Nominal Pipe Diameter, inches	Minimum Time, min:sec	Length for Minimum Time, ft	Increased Time for Longer Lengths, seconds per foot
4	3:46	597	.0380
6	5:40	398	0.854
8	7:34	298	1.520
10	9:26	239	2.374
12	11:20	199	3.418
18	17:00	133	7.692
24	22:40	99	13.674
30	28:20	80	21.366
36	34:00	66	30.768

G. Testing criteria of pipe 12-inches and larger may be adjusted if the ENGINEER approves. The air pressure decrease may be 0.5 psi instead of 1.0 psi, and the corresponding minimum times will be one-half of the tabulated times.

H. For pipe larger than 24-inches, air pressure tests may be performed on each joint. The time for the pressure to fall from 3.5 to 2.5 psi, both above groundwater pressure, shall not be less than 10 seconds regardless of pipe diameter.

I. If the time is less than the allowable time, the pipe will be considered defective and shall be repaired and retested.

3.6 MANHOLE, VAULT, OR CATCH BASIN TEST

A. Hydrostatic Testing: All pipes entering the manhole shall be sealed at a point outside the manhole walls to include testing of the pipe to manhole joints. The manhole shall be filled with water to a level 2-inches below the top of the frame. Safety lines shall be secured to all plugs utilized. After a period of at least one hour to allow the water level to stabilize, the manhole shall be refilled and the water level shall be marked. The water level shall again be checked after 4 hours. If the water level falls more than 1-inch, the leakage shall be considered excessive, and the CONTRACTOR shall make repairs and retest the manhole. The exterior of the manhole shall be inspected during this period for visible evidence of leakage. Visible moisture, sweating, or beads of water on the exterior of the manhole shall not be considered leakage, but any water running across the surface will be considered leakage and shall be repaired to the satisfaction of the ENGINEER regardless of the volume of water lost.

B. Vacuum Testing

1. Install the vacuum test head on top of the manhole. Install and brace sealing devices on influent and effluent pipes

2. With a vacuum pump, draw a vacuum of 10 inches of mercury, deactivate the pump, and measure the time in seconds for the vacuum to drop to 9 inches of mercury.

3. Compare the time to the table below.

Minimum Time, min: sec				
Manhole Depth, ft	**Manhole Diameter, inches**			
	36	48	60	72
8	0:14	0:20	0:26	0:33
10	0:18	0:25	0:33	0:41
12	0:21	0:30	0:39	0:49
14	0:25	0:35	0:48	0:57
16	0:28	0:40	0:52	1:7
18	0:32	0:45	0:59	1:13
20	0:35	0:50	1:5	1:21
22	0:38	0:55	1:12	1:30
24	0:42	0:59	1:18	1:37
26	0:46	1:4	1:25	1:45
28	0:49	1:9	1:31	1:53
30	0:53	1:14	1:38	2:1

4. If the time is less than the time in the table, the manhole is defective, and it shall be repaired and retested until it is acceptable.

END OF SECTION

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SECTION 01 74 30 - PRESSURE PIPE TESTING

PART 1 - GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall test water pipelines and appurtenant piping, in accordance with the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Contractor Submittals.

B. Furnish:

1. A testing plan and schedule, including method for water conveyance, control, and disposal shall be submitted in writing for approval.

PART 2 - PRODUCTS

2.1 MATERIAL REQUIREMENTS

A. All test equipment, temporary valves, bulkheads, and other water control equipment shall be as determined by the CONTRACTOR. No materials shall be used which would be injurious to the WORK.

PART 3 - EXECUTION

3.1 GENERAL

A. Coordinate with the OWNER to locate a suitable water source for testing water pipelines. The CONTRACTOR shall provide any temporary piping necessary to convey water from the OWNER-designated source to the points of use.

B. All new pipelines shall be tested.

3.2 HYDROSTATIC TESTING OF PIPELINES

A. 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. 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. The CONTRACTOR shall provide sufficient temporary tappings 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.

B. 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.

C. The hydrostatic test shall consist of holding the indicated test pressure on the pipeline segment for a period of 4 hours. The test pressure for buried piping shall be 50 psi, measured at the lowest point of the pipeline section being tested. 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.

D. The maximum leakage for buried piping shall be 0.02 U.S. gallons per hour per inch of diameter per 100 feet of pipe. 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.

END OF SECTION

SECTION 01 74 40 - CONCRETE STRUCTURE TESTING

PART 1 - GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall perform hydrostatic testing of all concrete structures designed to contain fluids in accordance with the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Contractor Submittals.

B. Include a testing plan and schedule, including methods for water conveyance and water disposal for approval.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIALS

A. Temporary valves, bulkheads, gauges, compressors, and other air and water control equipment shall be determined by the CONTRACTOR. Nothing shall be used which would be injurious to the WORK.

PART 3 - EXECUTION

3.1 PRELIMINARY CLEANING AND FLUSHING

A. Prior to testing, structures shall be cleaned by thoroughly hosing down all inner surfaces with a high pressure hose and nozzle of sufficient size to deliver a minimum flow of 50 gpm. Water, dirt, and foreign material accumulated in this cleaning operation shall be discharged from the structure or otherwise removed.

3.2 HYDRAULIC TESTING OF STRUCTURES

A. General

1. Water for testing will be furnished by the Contractor.

2. Release of water from structures after testing has been completed shall be as acceptable to the ENGINEER.

3. Testing shall be performed prior to backfilling except where otherwise acceptable to the ENGINEER. Testing shall not be performed sooner than 7 days after forms are removed or test cylinders from the roof concrete have reached 75 percent of the 28-day strength required by Section 03 31 00 – Cast-In-Place Concrete, whichever occurs later.

B. Leakage Test and Repairs: The leakage test shall be performed as follows:

1. The test shall consist of filling the structure with water to the maximum operating water surface. The rate of filling shall not exceed 24 inches of depth per day.

2. Inspect the structure for visible leakage. Locations with any visible leakage, as evidenced by liquid droplets, flowing water, or moist areas on the outside surface which only could have originated from inside the structure, will be considered defective and shall be repaired before testing proceeds.

3. An initial water level reading shall be made.

4. Seven days following the initial reading, a second reading shall be made. The structure shall be considered to have passed the test if water loss during the 7-day period, as computed from the two water level readings, does not exceed 0.2 percent of the total volume of water in the structure.

5. If intermediate readings or observed leakage indicate that the allowable leakage criterion will be exceeded, the test may be terminated before the end of the 7-day period and appropriate action taken to correct the problem before commencing a new 7-day test period.

6. If the structure fails to pass the test, the test may be repeated for up to 3 additional 7-day test periods. If, at the end of 28 days, the structure still fails to pass the leakage test, the CONTRACTOR shall empty the structure as acceptable to the ENGINEER and shall examine the interior for evidence of any cracking or other conditions that might be causing the leakage. Cracks shall be repaired in accordance with Section 03 01 30 – Concrete Repair and Rehabilitation. Any evidence of leakage shall be repaired.

7. Following these operations, the CONTRACTOR shall again test the structure. The structure will not be accepted until the water loss leakage test is passed and all visible leakage repaired.

3.3 TESTING OF APPURTENANT PIPING

A. Piping appurtenant to pneumatic structures shall be tested in accordance with Section 01 74 30 – Pressure Pipe Testing.

END OF SECTION

SECTION 01 75 00 – EQUIPMENT TESTING AND STARTUP

PART 1 - GENERAL

1.1 THE SUMMARY

A. Startup is prerequisite to satisfactory completion of the contract requirements and shall be completed within the Contract Times.

B. Conduct all test, 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. Startup and testing consists of three separate phases: Mechanical Checkout, Pre-Commissioning and Commissioning. Where manufacturer onsite inspections are required before startup, the manufacturer shall furnish a written statement that the installation and check out is complete and proper and that the item(s) are ready for startup.

C. Startup is a complex operation requiring the combined expertise of the CONTRACTOR, Subcontractors, the ENGINEER, and the 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.

F. During startup, supply water or reuse water shall be sent to an empty rearing pond or to the tailrace, unless indicated otherwise by the OWNER. Coordinate with OWNER to determine the acceptable discharge location(s).

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 involves balancing, adjustments, calibration, loop checks, and loop validation. 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 all testing and startup activities shall be shown submitted with construction progress schedules provided under Section 01 32 00 – Construction Progress Documentation.

B. Startup Plan: Not less than 30 Days prior to startup, submit for review a detailed Testing and Startup 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. Address coordination with the OWNER's staff.

9. Designate a representative of the CONTRACTOR who has the authority to act in matters relating to startup. The Plan shall also designate the roles and responsibilities of any Subcontractors that may be involved in startup activities.

10. Safety, startup, and testing procedures and proposed inspection and certification forms and records.

11. 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.

12. Hydrostatic testing of water-holding structures and pipelines and other potable water equipment per requirements of Sections 01 74 20 Gravity Pipeline Testing, 01 74 30 Pressure Pipe Testing, and 01 74 40 Concrete Structure Testing. Schedule and plan shall indicate source of water, testing and disinfection sequence, disinfection procedures, and the disposal of the water following disinfection as applicable.

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 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 3 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.

3.2 PREREQUISITES

A. Pre-commissioning and commissioning activities shall be scheduled ahead of time. The 3-Day pre-commissioning and the 3-Day commissioning tests shall start prior to midday on a Monday, Tuesday, or Wednesday. Testing periods shall not include holidays, based on the OWNER's calendar.

B. 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. Manufacturer's certifications of proper installation have been accepted.

4. Leakage tests, electrical tests, and adjustments have been completed.

5. The ENGINEER has approved the Startup Plan.

6. Temporary facilities are functional, adjusted, and ready for use.

7. Individual instrumentation loops (analog, status, alarm, and control) have been verified functionally.

8. Pressure switches, flow switches, timing relays, level switches, vibration switches, temperature switches, RTD monitors, pressure regulating valves, and other control devices to the settings determined by the ENGINEER or the equipment manufacturer have been adjusted for accuracy.

9. 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.

3.3 GENERAL

A. Supplies

1. The CONTRACTOR shall furnish:

a. Oil and grease

b. Other necessary materials not listed for the OWNER to furnish

c. Water

d. Power

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. Logs of electrical measurements and tests

4. Instrumentation calibration and testing logs

5. Testing and validation of SCADA inputs, outputs, logic functions, status indications, and alarms

6. Factory and field equipment settings

7. Log of problems encountered and remedial action taken

8. Other records, logs, and checklists as required by the Contract Documents

3.4 PRE-COMMISSIONING

A. 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.

B. Subject to the malfunction criteria above, each system shall be demonstrated for a continuous, 3 Day, 24 hour/day period. 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.

C. The CONTRACTOR shall demonstrate the manual and automatic modes of operation to verify proper control sequences, software interlocks, proper operation of software logic and controllers, etc. System testing shall include the use of water or other process media, as applicable, to simulate the actual conditions of operation.

D. 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.

E. The CONTRACTOR shall demonstrate utility, chemical feed, safety equipment, and other support systems before whole process systems.

F. Furnish the ENGINEER at least 10 Days written notice confirming the start of pre-commissioning. The OWNER's staff will observe pre-commissioning.

3.5 COMMISSIONING

A. The CONTRACTOR shall start up the plant and operate it without malfunction for a continuous 3 Day, 24 hour/day period. The ENGINEER will determine the operational parameters.

B. 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 judgement of the ENGINEER, be cause for extending the demonstration an equal amount of time.

C. Commissioning shall not begin until leakage tests, instrumentation tests and adjustments, electrical tests and adjustments, equipment field tests, and system tests have been completed to the satisfaction of the ENGINEER.

D. During commissioning, the CONTRACTOR shall:

1. Lubricate and maintain equipment in accordance with the manufacturers' recommendations.

2. Clean or replace strainers, screens, and filter elements.

3. Monitor and respond to equipment alarms generated by equipment malfunction.

END OF SECTION

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SECTION 01 77 00 – CLOSEOUT 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 administrative and procedural requirements for contract closeout, including, but not limited to, the following:

1. Substantial Completion procedures.

2. Final Completion procedures.

3. Warranties.

4. Operations and Maintenance Manuals

5. Final cleaning.

6. Repair of the Work.

B. Related Requirements:

1. Section 01 73 00 - Execution for progress cleaning of Project site.

2. Section 01 78 39 - Project Record Documents for submitting record Drawings, record Specifications, and record Product Data.

3. Final payment requires submittal of record drawings, specifications, and product data

1.2 ACTION SUBMITTALS

A. Product Data: For cleaning agents.

B. Contractor's List of Incomplete Items: Initial submittal at Substantial Completion.

C. Certified List of Incomplete Items: Final submittal at Final Completion.

1.3 CLOSEOUT SUBMITTALS

A. Certificates of Release: From authorities having jurisdiction.

B. Certificate of Insurance: For continuing coverage.

1.4 TECHNICAL AND OPERATIONS AND MAINTENANCE (O&M) MANUAL SUBMITTALS

A. Schedule of technical and Operations and Maintenance Material Items: For maintenance material submittal items specified in other Sections.

B. The CONTRACTOR shall submit technical operation and maintenance information for each item of mechanical, electrical, and instrumentation equipment in an organized manner in the Technical Manual.

C. The manual shall be written such that it can be used and understood by the OWNER's operation and maintenance staff. Each manual shall be customized to this project and specific equipment and all options shall be marked as provided or lined out as not provided.

D. Categories

1. The Technical Manual shall be subdivided first by Specification Section number; second, by equipment item; and last, by "Part." The following " Parts" shall be addressed (as applicable):

a. Part 1 - Equipment Summary

1) Summary: A table shall indicate the equipment name, equipment number, and process area in which the equipment is installed.

2) Form: The ENGINEER will supply an Equipment Summary Form for each item of mechanical, electrical, and instrumentation equipment in the WORK. The CONTRACTOR shall fill in the relevant information on the form and include it in Part 1.

b. Part 2 - Operational Procedures

1) Procedures: Manufacturer-recommended procedures on the following shall be included in Part 2:

Installation
Adjustment
Startup
Location of controls, special tools, equipment required, or related instrumentation needed for operation
Operation procedures
Load changes
Calibration
Shutdown
Troubleshooting
Disassembly
Reassembly
Realignment
Testing to determine performance efficiency
Tabulation of proper settings for pressure relief valves, low and high pressure switches, and other protection devices
List of all electrical relay settings including alarm and contact settings

c. Part 3 - Preventive Maintenance Procedures

1) Procedures: Preventive maintenance procedures shall include manufacturer-recommended procedures to be performed on a periodic basis, both by removing and replacing the equipment or component, and by maintaining the equipment in place.

2) Schedules: Recommended frequency of preventive maintenance procedures shall be included. Lubrication schedules, including lubricant SAE grade, type, and temperature ranges, shall be covered.

d. Part 4 - Parts List

1) Parts List: A complete parts list shall be furnished, including a generic description and manufacturer's identification number for each part. Addresses and telephone numbers of the nearest supplier and parts warehouse shall be included.

2) Drawings: Cross-sectional or exploded view drawings shall accompany the parts list. Part numbers shall appear on the drawings with arrows to the corresponding part.

e. Part 5 - Wiring Diagrams

1) Diagrams: Part 5 shall include complete internal and connection wiring diagrams for electrical equipment items.

f. Part 6 - Shop Drawings

1) Drawings: This Part includes approved shop or fabrication drawings with ENGINEER comments and corrections incorporated, complete with dimensions.

g. Part 7 - Safety

1) Procedures: This Part describes the safety precautions to be taken when operating and maintaining the equipment or working near it.

h. Part 8 - Documentation:

1) Equipment warranties, affidavits, certifications, calibrations, laboratory test results, etc. required by the Technical Specifications shall be placed in this Part.

E. Format

1. Bind each Technical Manual in standard size 3-ring hardcover binders, labeled on the spine and cover with Project name, OWNER's project number, Specification Section number, equipment name, and equipment identification number. Binder shall be 3” white or black with back mounted ring with gap free locking ring, Avery 68041, or equal.

2. Each Binder shall contain its own detailed table of contents at the front, plus a summary level table of contents information for the other binders/Volumes in a multi-binder set. Each binder shall be identified as a Volume clearly labeled on the cover and at the Top or bottom on the spline with vertical text when standing on a shelf. The order of sections shall be by Specification number. Table of content and sections shall be identified first by Specification number, Item Name and the by equipment Tag number (if applicable).

3. Documents in binders shall be 3-hole punched, with no text punched out, and pages larger than 8-1/2 inch by 11 inch shall be folded to 8-1/2 inch by 11 inch size. Color copies shall be provided of colored contents.

4. Provide a CD with electronic files with each final set of Technical Manuals, as follows:

   a. Project-specific files created in Microsoft Office, latest version;

   b. AutoCad, latest version;

   c. Portable Document Format (PDF) or other software required by the Specifications; and,

   d. Manufacturer literature in Adobe Acrobat portable document format (PDF).

F. Submittal and Review Process

1. Draft Technical Manuals: Draft submittal(s) may be submitted may be submitted separately by complete section, Volume, or full set with all Volumes. Each Draft submittal shall be submitted as a separate submittal. If a resubmittal is necessary, all resubmittals up to the Final Draft Submittal shall be resubmitted under the same submittal number with different resubmittal number. Draft submittals shall be submitted in pdf format with all parts included in a single file organized for direct printing with divider pages between sections, cover, table of contents, etc. Where information is not final at the time of the Draft submittal representative/sample pages shall be included indicating what information will be provided, and those pages shall be clearly marked PLACEHOLDER. Every Draft submittal shall include the complete Table of contents for all volumes and the detailed table of content for the submitted document.

2. Final Draft Technical Manual: Final Draft submittal shall be complete with all Volumes and sections complete except for those items to be replaced with as-built or post startup certifications. Where information is not final at the time of the Final Draft Technical Manual submittal representative/sample pages shall be included indicating what information will be provided, and those pages shall be clearly marked PLACEHOLDER. The Final Draft Technical Manual submittal shall be complete in every way except for the final material to be inserted. The submittal shall include 2-DVD’s containing the complete set organized by Volume and one complete hard copy set.

3. Final Technical Manual: Incorporate comments from the Final Draft and submit 1 hard-copy set of the final manual for acceptance and 3-DVD electronic copies.

1.3 SUBSTANTIAL COMPLETION PROCEDURES

A. Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's punch list), indicating the value of each item on the list and reasons why the Work is incomplete.

B. Submittals Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.

1. Certificates of Release: Obtain and submit releases from authorities having jurisdiction permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.

2. Submit closeout submittals specified in other Division 01 Sections, including project record documents, operation and maintenance manuals, final completion construction photographic documentation, damage or settlement surveys, property surveys, and similar final record information.

3. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.

4. Submit test/adjust/balance records.

5. Submit sustainable design submittals not previously submitted.

6. Submit changeover information related to Owner’s occupancy, use, operation, and maintenance.

C. Procedures Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.

1. Advise Owner of pending insurance changeover requirements.

2. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner’s personnel of changeover in security provisions.

3. Complete startup and testing of systems and equipment.

4. Perform preventive maintenance on equipment used prior to Substantial Completion.

5. Advise Owner of changeover in heat and other utilities.

6. Participate with Owner in conducting inspection and walkthrough with local emergency responders.

7. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.

8. Complete final cleaning requirements, including touchup painting.

9. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.

10. Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of 10 days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, Owner will either proceed with inspection or notify Contractor of unfulfilled requirements. Owner will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Owner, that must be completed or corrected before certificate will be issued.

11. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

12. Results of completed inspection will form the basis of requirements for final completion.

1.4 FINAL COMPLETION PROCEDURES

B. Submittals Prior to Final Completion: Before requesting final inspection for determining final completion, complete the following:

1. Submit a final Application for Payment according to Section 01 29 00 - Payment Procedures.

2. Certified List of Incomplete Items: Submit certified copy of Owner's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Owner. Certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.

3. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.

C. Inspection: Submit a written request for final inspection to determine acceptance a minimum of 10 days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, Owner will either proceed with inspection or notify Contractor of unfulfilled requirements. Owner will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.

1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.5 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.

1. Organize list of spaces in sequential order, starting with exterior areas first.

2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.

3. Include the following information at the top of each page:

4. Project name.

    a. Date.

    b. Name of Owner.

    c. Name of Contractor.

    d. Page number.

5. Submit list of incomplete items in the following format:

    a. MS Excel electronic file. Owner will return annotated file.

1.6 SUBMITTAL OF PROJECT WARRANTIES

A. Time of Submittal: Submit written warranties on request of Owner for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated, or when delay in submittal of warranties might limit Owner's rights under warranty.

B. Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.

1. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2 by 11-inch paper.

2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.

3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.

4. Warranty Electronic File: Scan warranties and bonds and assemble complete warranty and bond submittal package into a single indexed electronic PDF file with links enabling navigation to each item. Provide bookmarked table of contents at beginning of document.

C. Provide additional copies of each warranty to include in operation and maintenance manuals.

PART 2 -- PRODUCTS

2.1 MATERIALS

A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

B. Use cleaning products that comply with Green Seal's GS-37, or if GS-37 is not applicable, use products that comply with the California Code of Regulations maximum allowable VOC levels.

PART 3 -- EXECUTION

3.1 FINAL CLEANING

A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.

B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.

1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:

   a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.

   b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.

   c. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.

   d. Remove tools, construction equipment, machinery, and surplus material from Project site.

   e. Remove debris and surface dust from limited access spaces, including trenches, equipment vaults, manholes, and similar spaces.

   f. Remove labels that are not permanent.

   g. Wipe surfaces of mechanical and electrical equipment and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.

   h. Leave Project clean and ready for occupancy.

3.2 REPAIR OF THE WORK

A. Complete repair and restoration operations before requesting inspection for determination of Substantial Completion.

B. Repair or remove and replace defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to their specified condition.

1. Remove and replace chipped, scratched, and broken glass, reflective surfaces, and other damaged transparent materials.

2. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that that already show evidence of repair or restoration.

3. Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates. Remove paint applied to required labels and identification.

4. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.

END OF SECTION

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SECTION 01 78 39 – PROJECT RECORD DOCUMENTS

1 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 administrative and procedural requirements for project record documents, including the following:

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

B. Related Requirements:

1. Section 01 73 00 "Execution" for final property survey.
2. Section 01 77 00 "Closeout Procedures" for general closeout procedures.

1.3 CLOSEOUT SUBMITTALS

A. Record Drawings: Comply with the following:

1. Number of Copies: Submit copies of record Drawings as follows:
   a. Initial Submittal:
      1) Submit PDF electronic files of scanned record prints and one of file prints.
      2) Owner will indicate whether general scope of changes, additional information recorded, and quality of drafting are acceptable.
   b. Final Submittal:
      1) Submit PDF electronic files of scanned record prints and three set(s) of prints.

B. Record Specifications: Submit annotated PDF electronic files of Project's Specifications, including addenda and contract modifications.

C. Record Product Data: Submit annotated PDF electronic files and directories of each submittal.

1. Where record Product Data are required as part of operation and maintenance manuals, submit duplicate marked-up Product Data as a component of manual.

2 PRODUCTS

2.1 RECORD DRAWINGS

A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and

Shop Drawings, incorporating new and revised drawings as modifications are issued.

1. Preparation: Mark record prints to show the actual installation where installation varies

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from that shown originally (Asbuilts). Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.

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

2. Content: Types of items requiring marking include, but are not limited to, the following:
   a. Dimensional changes to Drawings.
   b. Revisions to details shown on Drawings.
   c. Locations and depths of underground utilities.
   d. Revisions to routing of piping and conduits.
   e. Revisions to electrical circuitry.
   f. Actual equipment locations.
   g. Duct size and routing.
   h. Changes made by Change Order or Construction Change Directive.
   i. Changes made following Owner's written orders.
   j. Details not on the original Contract Drawings.
   k. Field records for variable and concealed conditions.
   l. Record information on the Work that is shown only schematically.

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

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

1. Record Prints: Organize record prints and newly prepared record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
2. Format: Annotated PDF electronic file with comment function enabled.
3. Record Digital Data Files: Organize digital data information into separate electronic files

that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each digital data file.

4. Identification: As follows:
   a. Project name.
   b. Date.

c. Designation "PROJECT RECORD DRAWINGS."
d. Name of Owner.
e. Name of Contractor.

2.2 RECORD PRODUCT DATA

A. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
3. Note related Change Orders and record Drawings where applicable.

B. Format: Submit record Product Data as annotated PDF electronic file.

3 EXECUTION

3.1 RECORDING AND MAINTENANCE

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

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

END OF SECTION

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SECTION 01 79 00 - OWNER STAFF TRAINING

PART 1 - GENERAL

1.1 THE SUMMARY

A. Where specified, the CONTRACTOR shall furnish all labor, materials, equipment, and incidentals necessary to train OWNER's personnel on the equipment, products, and systems furnished under this Contract. OWNER training is a prerequisite to satisfactory completion of the Contract requirements and shall be completed within the Contract Time.

B. The minimum onsite training requirements for applicable equipment is described in the respective sections of the specifications.

C. Except where otherwise indicated, all costs for training shall be the responsibility of the CONTRACTOR.

D. Approved Technical manuals shall be available at least 14 days prior to the scheduled date for the individual training session.

1.2 SUBMITTALS

A. **Training Schedule:** Schedule for training the OWNER's personnel shall be submitted with the detailed Testing and Startup Plan required by Section 01 75 00 – Equipment Testing and Startup.

1. Training classes shall be organized in conjunction with the equipment startup, as defined in Section 01 75 00 – Equipment Testing and Startup . Each training class shall consist of a classroom portion and a field tour portion. Each training class shall include:

a. Training on each item of equipment, conducted by the Equipment Manufacturer's representative.

b. Training on the mechanical piping system within the system, conducted by the CONTRACTOR'S mechanical superintendent.

c. Training on the power distribution system and alarms within the system, conducted by the CONTRACTOR'S electrical superintendent.

2. Training classes shall be scheduled a minimum of four (4) weeks in advance of the date of the first class to allow OWNER staffing arrangements to take place. The CONTRACTOR shall schedule training classes within the period 7:30 a.m. to 3:30 p.m. Monday through Friday.

1.3 INSTRUCTOR QUALIFICATIONS

A. Instructors shall be completely knowledgeable in the products and systems for which they are providing training and shall be experienced in conducting classes. Sales representatives are not considered qualified instructors unless they possess the detailed operating and maintenance knowledge required for proper class instruction.

B. Instructor shall have at least two years of experience in providing training certified by the Manufacturer.

C. If, in the opinion of the OWNER, the Instructor did not provide the scheduled training, such training shall be rescheduled and repeated with a suitable instructor at the CONTRACTOR's expense.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

A. The objective of the training included under this Section shall be to convey the knowledge needed by the OWNER operations, maintenance, and engineering staff to safely operate, maintain, and repair the equipment and systems furnished under this CONTRACT.

B. Training shall be tailored to suit the skills and job classifications of the personnel attending the classes e.g., hatchery manager, hatchery operator, maintenance technical, , etc.

C. Minimum onsite training requirements for components are described in various sections of the Specifications. For the purpose of the times given in individual Specification sections, a workday is defined as an eight (8) hour day at the site, excluding travel time.

D. Training shall not be done until the manufacturer certifies that the equipment is operable as specified.

3.2 LOCATION

A. Training sessions shall take place at OWNER's office area or at another location as mutually agreed between the OWNER and the CONTRACTOR.

3.3 TRAINING CLASSES

A. Number of Classes on Each Subject: Provide the number of training sessions as indicated in the respective equipment sections of the specifications.

B. Cancellation of Training: If a training must be canceled because the equipment is not ready for operation, etc. the CONTRACTOR shall notify the OWNER at least one (1) week in advance. The CONTRACTOR shall coordinate with the OWNER to reschedule the training.

3.4 TRAINING AIDS

A. Training Aids: Each instructor is encouraged to use audio-visual devices, P&IDs, models, charts, etc. to increase the transfer of knowledge. The CONTRACTOR shall provide all such equipment (televisions, videocassette recorder/player, projectors, screens, easels, models, charts, etc.) needed for each training session. It shall be the responsibility of the CONTRACTOR to confirm in advance that the training room set-up will be appropriate for the types of audiovisual equipment to be employed.

B. Classroom Documentation: If training is being completed on equipment, systems, or products for which a Technical Manual is required, the draft Technical Manual shall have been returned by the OWNER with a status of "No Exceptions Taken" or "Make Corrections Noted" before the training class is scheduled. The approved Technical Manual shall be used during the classroom instruction. Supplemental documentation

handouts shall be provided by the organization conducting the training as required to the support instruction.

3.5 FORMAT AND CONTENT

A. Each training session shall be comprised of time spent both in the classroom and at the specific location of the subject equipment or system. As a minimum, training session shall cover the following subjects for each item of equipment or system:

1. Familiarization

   a. Review catalog, parts lists, drawings, etc., which have been previously provided for the OWNER’s files and operation and maintenance manuals.

   b. Inspection on how the equipment has been installed. Demonstrate the operation of the unit and describe how all parts of the equipment meet the requirement of the Specifications.

   c. Answer questions.

2. Safety

   a. Using material previously provided, review safety features of the equipment.

   b. Discuss proper precautions when working around equipment.

3. Operation

   a. Using material previously provided, review reference literature.

   b. Explain all modes of operation (including emergency).

   c. Check out OWNER's personnel on proper use of the equipment.

4. Preventive Maintenance

   a. Using material previously provided, review preventive maintenance (PM) lists including reference materials and daily, weekly, quarterly, semi-annual, and annual PM activities.

   b. Demonstrate how to perform Preventive Maintenance procedures.

   c. Demonstrate to the OWNER's personnel what to look for as indicators of potential equipment problems.

5. Corrective Maintenance

   a. Identify possible problems.

   b. Demonstrate how to perform repairs. Point out special problems.

   c. Open up equipment and demonstrate O & M procedures, where practical.

6. Parts

a. Demonstrate the use of previously provided parts list and order parts.

b. Review spare parts on hand. Make recommendations regarding replacement schedules are how to obtain additional spare parts.

7. Local Representatives

a. Identify local vendors where to order parts: name, address, telephone.

b. Service problems:

8. Technical Manuals

a. Review any other material submitted.

b. Update material, as required.

3.6 DOCUMENTATION OF TRAINING

A. The OWNER reserves the right to videotape, photograph, audio record, and otherwise document any or all training classes provided under this WORK.

END OF SECTION

SECTION 02 41 19 - DEMOLITION AND RECONSTRUCTION

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The Contractor shall demolish the existing civil, structural, mechanical, electrical, and instrumentation facilities as indicated, in accordance with the Contract Documents.

1.2 COORDINATION

A. The Contractor shall carefully coordinate the Work in areas where existing facilities are interconnected with new facilities and where existing facilities remain operational. The Work as indicated is not all-inclusive, and the Contractor shall be responsible to perform the reconstruction indicated plus that which can be reasonably inferred from the Contract Documents as necessary to complete the Project. The Specifications and Drawings identify the major facilities that shall be demolished and reconstructed, but auxiliary utilities such as water, drainage, electrical wiring, and instrumentation are not necessarily shown.

B. The Contractor shall note that the Drawings indicating demolition and reconstruction are based on a ground survey of the existing facilities. Prior to Bidding, the Contractor shall conduct a comprehensive survey at the Site to verify the correctness and exactness of the Drawings, the scope of Work, and the extent of auxiliary utilities.

C. While demolition and construction are being performed, the Contractor shall provide adequate access for some continued operations such as juvenile fish releases and water quality sampling. The Contractor shall erect and maintain fences, warning signs, barricades, and other devices around the reconstruction as required for the protection of the Contractor 's employees and the Owner 's personnel. The Contractor shall remove such protection when construction activities are complete, or as Work progresses, or when requested by the Engineer.

1.3 CONTRACTOR SUBMITTALS

A. Demolition and construction activities and procedures, including operational sequences, shall be submitted to the Engineer for approval. The procedures shall provide for safe conduct of the Work, careful removal and disposition of materials and equipment, protection of existing facilities which are to remain undisturbed, coordination with existing facilities to remain in service, and timely disconnection and reconnection of utility services. The procedures shall include a detailed description and time schedule of the methods and equipment to be used for each operation and the sequence of operation. A storage plan for salvaged items shall be included.

1.4 DEMOLITION

A. Existing pavement, structures, equipment, piping, valves, electrical gear, instrumentation, utilities, and related appurtenances such as anchors, supports, and hardware indicated or required to be demolished as part of the Work shall be removed and disposed of unless otherwise indicated. Removal of buried structures, utilities, and appurtenances includes

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the related excavation and backfill as required. Removed items shall be disposed of offsite by the Contractor.

B. Items to be removed include:

Item	Description
Flow Splitting Box Structure weir plates and existing pipe connections	Internal weirs where replaced by new elements, abandoned or modified piping connections.
Holding Pens and Collection Chamber Structure	Includes the entire concrete structure, fencing, and pipe
Lower Pond Bird Exclusion System	Including columns, netting, and appurtenances
Electrical Service and light poles	Existing electrical panels will be replaced, and new conduit and wiring will be provided for all equipment requiring power. Light poles will be offered to the Owner for salvage. Dispose if salvage not preferred.
Spawning Shed	Includes the hoist, the structure, the concrete slab, and electrical items.
Fish Ladder	The upstream portion of the fish ladder will be demolished including the fencing, walkways, gates, screens, and hoist. The walkway along the Lower Dam spillway will be removed and replaced, but the screens, and predator prevention posts and cable shall be demolished.
Lower Dam Spillway	The lower dam spillway concrete apron will be demolished to allow the construction of new concrete stairs.
Fencing	Fencing and fence gates where shown to be removed
Seal Barrier pickets	PVC picket panels for the seal barrier except for the end closures, support columns and guy wires, and the cable supports.

1.5 SALVAGE

A. Items of existing equipment, piping, valves, electrical gear, instrumentation, utilities, and appurtenances indicated to be salvaged shall be removed without any degradation in condition from that prior to removal. Salvaged items shall be stockpiled and protected on the Site at a location chosen by the Engineer. The Contractor shall be responsible to

properly safeguard the salvaged items against damage and loss during removal and handling.

B. Note that the existing fish ladder is planned for partial demolition beginning at an existing concrete seam/cold joint adjacent to the Tidal Benchmark (Tidal 8) as shown in the contract drawings.

1.6 RELOCATION

A. Items of existing equipment, piping, valves, electrical gear, instrumentation, utilities, and appurtenances to be relocated shall be removed without any degradation in condition from that prior to removal. The Contractor shall be responsible to properly safeguard the relocated items against damage and loss during removal, handling, storage, and installation in the new location.

1.7 ABANDONMENT

A. Items of existing equipment, piping, valves, electrical gear, instrumentation, utilities, and appurtenances to be abandoned shall be prepared by the Contractor as indicated.

1.8 REHABILITATION

A. Existing civil, landscaping, structural, architectural, mechanical, HVAC, electrical, and instrumentation Work disturbed or damaged by reconstruction activities shall be repaired and rehabilitated as indicated.

B. Damaged items shall be repaired or replaced with new items to restore items or surfaces to a condition equal to and matching that existing prior to damage.

C. The Contractor shall not use any Owner equipment unless authorized in advance in writing by the Engineer. Such authorization shall be subject to documentation by the Contractor of the proposed load on the equipment and be subject to Owner requirements for usage on operating and maintenance needs. Any damage to any equipment shall be repaired or replaced to the Engineer 's satisfaction.

1.9 DISPOSAL

A. The Contractor shall be responsible for the offsite disposal of debris resulting from reconstruction in compliance with local, state, and federal codes and requirements.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION

3.1 GENERAL

A. The Contractor shall coordinate demolition and reconstruction Work with the Owner and Engineer. Unless otherwise indicated, the Contractor shall be responsible for the sequence of activities. Work shall be performed in accordance with applicable safety rules and regulations.

B. The Contractor shall verify that any utilities connected to structures, equipment, and facilities to be removed, relocated, salvaged, replaced, or abandoned are rendered inoperable, replaced with new utilities, or adequately bypassed with temporary utilities before proceeding with demolition and construction.

C. The Contractor shall take precautions to avoid damage to adjacent facilities and to limit the Work activities to the extent indicated. If demolition or construction beyond the scope indicated is required, the Contractor shall obtain approval from the Engineer prior to commencing.

3.2 PROTECTION OF EXISTING FACILITIES

A. Before beginning any reconstruction, the Contractor shall carefully survey the existing facilities and examine the Specifications and Drawings to determine the extent of reconstruction and coordination with the Work. Existing facilities not subject to demolition or reconstruction shall be protected and maintained in accordance with Section 01 50 10 - Protection of Existing Facilities. Damaged existing facilities shall be repaired to the previous condition or replaced.

B. Persons shall be afforded safe passages around areas of demolition.

C. Structural elements shall not be overloaded. The Contractor shall be responsible for shoring, bracing, or adding new supports as may be required for adequate structural support as a result of Work performed under this Section. The Contractor shall remove temporary protection when the Work is complete or when so authorized by the Engineer.

D. The Contractor shall carefully consider bearing loads and capacities before placement of equipment and material on Site. In the event of any questions as to whether an area to be loaded has adequate bearing capacity, the Contractor shall consult with the Engineer prior to the placement of such equipment or material.

3.3 DEMOLITION, SALVAGE, AND RELOCATION

A. The Contract Documents indicate existing facilities to be demolished, salvaged, and/or relocated. Auxiliary utilities including such services as water, air, chemicals, drainage, lubrication, fluid power, electrical wiring, controls, and instrumentation are not necessarily indicated. The Contractor shall verify the scope of the Work to remove the equipment indicated; coordinate its shutdown, removal, replacement, or relocation; and submit an outage plan. The removal of existing facilities for demolition, salvage, and relocation shall include the following requirements:

1. Exposed electrical conduits and associated wiring shall be removed.

2. Coordinate with the Owner on the removal and salvage of the cellular modem.

3. Auxiliary utility support systems shall be removed.

4. The area shall be thoroughly cleaned such that little or no evidence of the previous equipment installation will remain.

5. Asphalt pavement shall be cut to transition with the new asphalt. The limits of removal shall be sawcut.

6. When existing pipe is removed, the Contractor shall plug the resulting open ends whether or not so indicated. Where removed piping is exposed, the remaining piping shall be blind-flanged or fitted with a removable cap or plug.

7. When existing piping is removed from existing structures, the Contractor shall fill resulting openings in the structures and repair any damage such that the finished rehabilitated structure shall appear as a new homogeneous unit with little or no indication of where the new and old materials join. The openings in water-bearing structures shall be filled with non-shrink grout to be watertight and reinforced as required or indicated. In locations where the surface of the grout will be exposed to view, the grout shall be recessed approximately 1/2-inch and the recessed area filled with cement mortar grout

8. Electrical construction shall be conducted by the Contractor in a safe and proper manner to avoid injury from electrical shock to the Owner 's and Contractor 's personnel. Electrical equipment to be shut off for a period of time shall be tagged, locked out, and sealed with a crimped wire and lead seal and made inoperable. At no time shall electrical wiring or connections which are energized or could become energized be accessible to Contractor, Owner, or other personnel without suitable protection or warning signs.

3.4 ABANDONMENT

A. Existing facilities to be abandoned shall be prepared as indicated. Where existing buried piping is to be abandoned, the Contractor shall remove the abandoned pipe for a distance of 5-feet from any connecting structures. Openings at the existing structures shall be repaired. The remaining pipe shall be capped at both ends prior to backfill. Buried piping, 12-inches diameter or greater shall be completely sand-filled prior to closure of the piping ends.

B. The existing 18-inch outlet pipe from the Flow Splitting Box shall be abandoned as soon as possible.

3.5 REHABILITATION

A. Certain areas of existing structures, piping, conduits, and the like will be affected by Work necessary to complete modifications under this Contract. The Contractor shall be responsible to rehabilitate those areas affected by its construction activities.

B. Where new piping is installed in existing structures, the Contractor shall accurately position core-drilled openings in the concrete as indicated or otherwise required. Openings shall be of sufficient size to permit a final alignment of pipelines and fittings without deflection of any part and to allow adequate space for satisfactory packing where pipe passes through the wall to provide watertightness around openings so formed. The boxes or cores shall be provided with continuous keyways to hold the filling material in place, and they shall have a slight flare to facilitate grouting and the escape of entrained air during grouting. Before placing the non-shrink grout, concrete surfaces shall be sandblasted, thoroughly cleaned of sand and any other foreign matter, and coated with epoxy bonding compound.

C. Pipes, castings, or conduits shall be grouted in place by pouring in grout under a head of at least 4-inches. The grout shall be poured or rammed or vibrated into place to fill completely the space between the pipes, castings, or conduits, and the sides of the openings so as to obtain the same watertightness as through the wall itself. The grouted casings shall then be water cured.

D. In locations where the surface of the grout will be exposed to view, the non-shrink grout shall be recessed approximately 1/2-inch and the recessed area filled with cement mortar grout.

E. When new piping is to be connected to existing piping, the existing piping shall be cut square and ends properly prepared for the connection. Any damage to the lining and coating of the existing piping shall be repaired. Dielectric insulating joints shall be installed at interconnections between new and existing piping.

F. Where existing equipment, piping, and supports, electrical panels and devices, conduits, and associated appurtenances are removed, the Contractor shall rehabilitate the affected area such that little or no evidence of the previous installation remains. Openings in concrete floors, walls, and ceilings from piping, conduit, and fastener penetrations shall be filled with non-shrink grout and finished to match the adjacent area. Abandoned connections to piping and conduits shall be terminated with blind flanges, caps, and plugs suited for the material, type, and service of the pipe or conduit.

G. Existing reinforcement to remain in place shall be protected, cleaned, and extended into new concrete. Existing reinforcement not to be retained shall be cut-off as follows:

1. Where new concrete joins existing concrete at the removal line, reinforcement shall be cut-off flush with the concrete surface at the removal line.

2. Where the concrete surface at the removal line is the finished surface, the reinforcement shall be cut back 2-inches below the finished concrete surface, the ends painted with epoxy paint and the remaining holes patched with a cement mortar grout.

H. Where existing handrailing or ladder is removed, post embedments and anchors shall be removed and post holes shall be filled with non-shrink grout flush to the floor surface. At the point of continuation of existing handrailing, a new post with rail connections matching the existing handrailing system shall be installed. New posts in existing concrete floors shall be installed in core-drilled socket holes and the annular space between the post and hole filled with non-shrink grout.

I. Where reconstruction activities damage the painting and coating of adjacent or nearby facilities, the damaged areas shall be surface prepared and coated in accordance with Section 09 96 00 - Protective Coating to match the original painting and coating with a compatible system. Surfaces of equipment items that are to be relocated shall be prepared and be coated in accordance with Section 09 96 00 – Protective Coating.

3.6 DISPOSAL

A. Demolition and removal of debris shall minimize interference with roads, streets, walks, and other adjacent occupied or used facilities that shall not be closed or obstructed without permission from the Owner. Alternate routes shall be provided around closed or obstructed traffic ways.

B. Site debris, rubbish, and other materials resulting from reconstruction operations shall be legally removed and disposed of. Structures and equipment to be demolished shall be cleaned prior to demolition and the wash water properly disposed of. No trace of these structures shall remain prior to placing of backfill in the areas from which structures were removed.

C. Refuse, debris, and waste materials resulting from demolition and clearing operations shall not be burned.

3.7 OCCUPANCY AND POLLUTION CONTROL

A. Water sprinkling, temporary enclosures, chutes, and other suitable methods shall be used to limit dust and dirt rising and scattering in the area. The Contractor shall comply with regulations pertaining to environmental protection.

B. Water shall not be used if it creates hazardous or objectionable conditions such as ice, flooding, or pollution.

3.8 CLEANING

A. During and upon completion of Work, the Contractor shall promptly remove tools and equipment, surplus materials, rubbish, debris, and dust and shall leave areas affected by Work in a clean, approved condition.

B. Adjacent structures shall be cleaned of dust, dirt, and debris caused by reconstruction, as requested by the Engineer or directed by governing authorities, and adjacent areas shall be returned to condition existing prior to start of Work.

C. The Contractor shall clean and sweep the street and road daily.

END OF SECTION

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SECTION 03 01 30 - CONCRETE REPAIR AND REHABILITATION

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Remove, repair, or rehabilitate new and existing concrete members and surfaces as indicated.

B. Provide all materials and equipment necessary to accomplish the WORK.

C. Repair damage to concrete and concrete surfaces which results from the removal of embedded items, from construction activities, or which existed previously in structures indicated to be repaired.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

ACI 201.1R-08	Guide for Conduction a Visual Inspection of Concrete in Service
ACI 546R-14	Guide to Concrete Repair

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Submittal Procedures.

B. Shop Drawings

1. Submit Shop Drawings for strengthening required around new openings.

2. Submit detailed drawings showing proposed methods for supporting existing structures, equipment, and piping during demolition and repair activities.

C. Concrete Repair Products and Procedures

1. Submit a comprehensive plan for each repair method indicated within this Section, the plan shall include the following:

a. Manufacturer's literature containing instructions and recommendations on the mixing, handling, placement, curing, and appropriate uses for each product.

b. Curing products and procedures for each repair method for which curing is recommended by the manufacturer.

1.4 QUALIFICATIONS OF CONCRETE RESTORATION FIRMS

A. The concrete restoration WORK shall be performed by an experienced firm customarily engaged in performing similar repair work on cast-in-place concrete structures.

B. The restoration firm shall have completed at least 5 similar projects in the last 5 years.

C. The restoration firm shall be certified by the manufacturer of the repair materials.

1.5 QUALITY ASSURANCE

A. General

1. Any material, already placed, which fails to meet the indicated performance requirements is subject to removal and replacement as part of the WORK.

2. The CONTRACTOR shall supply all necessary materials for fabricating the test specimens.

B. Repair Mortar

1. The CONTRACTOR's approved agency per 2015 IBC Section 1704 shall take compression test specimens during construction from the first placement of each type of repair mortar.

2. The cost of laboratory tests on repair mortar shall be paid by the CONTRACTOR, and the CONTRACTOR shall be responsible for the cost of any additional tests and investigation on the WORK that does not meet the indicated requirements.

3. The compression tests and fabrication of specimens for repair mortar shall be performed as specified in ASTM C 109.

a. A set of 3 specimens shall be made for testing at 7 days and 28 days, and an additional 2 specimens shall be made and held in reserve.

C. Non-Shrink Grout: Non-shrink grout shall be tested as required in Section 03 60 00 – Grouting.

D. Repair Concrete: Repair concrete shall be tested as required in Section 03 31 00 – Cast-in-Place Concrete.

E. Epoxy Grout: Epoxy grout shall be tested as required in Section 03 60 00 – Grouting.

F. Construction Tolerances: Construction tolerances shall comply with the requirements of Section 03 31 00 – Cast-in-Place Concrete, except as otherwise indicated.

PART 2 -- PRODUCTS

2.1 REPAIR MORTAR

A. Provide repair mortar as a pre-packaged, 2-component, polymer-modified, cementious, non-sag mortar, specifically formulated for the repair of surface defects.

B. Provide the mortar with a penetrating corrosion inhibitor.

C. Repair mortar shall have the following properties:

Physical Property	Value	ASTM Standard
Compressive Strength (min.)		C-109
at 7 days	6000 psi	
at 28 days	7000 psi	
Bond Strength (min.) at 28 days	2200 psi	C-882 (modified)
Freeze/Thaw resistance (min.) 300 cycles	98 percent	C-666

D. Provide a minimum repair thickness of 1/4 inch, unless otherwise indicated.

E. Repair Mortar shall be **SikaTop 123 Plus**, by **Sika Corporation**, or equal.

2.2 NON-SHRINK GROUT

A. Provide non-shrink grout conforming to the requirements of Section 03 60 00 – Grouting.

2.3 CONCRETE MATERIALS

A. Cement

1. Use Type II Portland cement unless otherwise indicated.

2. Where repairs are to be made on wall surfaces open to view and above normal water surface elevations, blend white Portland cement with the Type II cement as needed in order to match the color of the adjacent existing concrete surface.

B. Structural Repair Grout

1. Where required, provide structural repair grout meeting the requirements of Section 03 60 00 – Grouting.

2. Provide a minimum repair thickness of 3 inches.

C. Cement Grout

1. Provide cement grout that meets the requirements of Section 03 60 00 – Grouting.

2. Provide a minimum repair thickness of one inch.

D. Miscellaneous Materials**:** For concrete construction materials not covered specifically in this Section, conform to the requirements of Section 03 31 00 – Cast-in-Place Concrete.

2.4 AGGREGATE

A. Obtain the written permission of the manufacturer and ENGINEER before using aggregate to extend repair mortar and grout products.

B. If allowed and unless otherwise indicated, provide aggregate consisting of 3/8-inch clean, washed gravel or crushed stone as required in Section 03 31 00 – Cast-in-Place Concrete.

2.5 BONDING AGENT AND ANTI-CORROSION COATING

A. Provide a bonding agent that is a solvent-free, moisture-tolerant, epoxy-modified, cementitious product, specifically formulated as a bonding agent and anti-corrosion coating.

B. Bonding Agent shall be **Armatec 110 EpoCem**, by **Sika Corporation**, or equal.

2.6 EPOXY GROUT

A. Provide an epoxy grout conforming to the requirements of Section 03 60 00 – Grouting.

2.7 EPOXY RESIN

A. Use epoxy resin for structural crack repair.

B. For crack injection, provide a 2-component, moisture-tolerant, low-viscosity, high-strength epoxy resin adhesive that is specially formulated for that usage.

C. Provide a minimum bond strength of 2900 psi when tested per ASTM C 882 at 14 days, moist cured.

D. Epoxy Resin shall be **Sikadur 35, Hi-Mod LV**, by **Sika Corporation**, **KEMKO 068 LoVis IR**, by **ChemCo Systems, Inc.**, or equal.

2.8 FORMWORK

A. Where needed, provide formwork that meets the requirements of Section 03 11 00 – Concrete Formwork.

2.9 REINFORCEMENT STEEL

A. Where required, provide reinforcing steel that meets the requirements of Section 03 21 00 – Reinforcement Steel.

2.10 POLYURETHANE SEALANT

A. Provide a 2-part polyurethane, gun-grade sealant.

B. Polyurethane Sealant shall be **Sikaflex – 2C**, by **Sika Corporation**, or equal.

2.11 POLYURETHANE CHEMICAL GROUT

A. Use polyurethane chemical grout for non-structural crack repair.

B. Polyurethane Chemical Grout shall be **SikaFix HH**, by **Sika Corporation**, **Flex LV PURe**, by WR **Grace/De Neef**, **Flex SLV PURe**, by **WR Grace/De Neef**, or equal.

2.12 EXPANSION JOINTS

A. Provide an expansion joint system for repair of the existing expansion joints, consisting of a Hypalon sealing strip and an epoxy adhesive in order to provide a watertight seal.

B. Expansion Joint System shall be **Sikadur Combiflex**, by **Sika Corporation**, or equal.

2.13 HYDROPHILIC WATERSTOP

A. Provide hydrophilic waterstop of the type which expands in the presence of water to form a watertight joint seal without damaging the concrete in which it is cast.

B. Provide hydrophilic waterstop that is bentonite-free and manufactured from chloroprene rubber and modified chloroprene rubber with hydrophilic properties.

C. Hydrophilic Waterstop shall be **Hydrotite RSS-040 P**, by **Greenstreak Group, Inc.**, KM **4mm String**, by **Adeka Ultra Seal**, or equal.

2.14 HIGH STRENGTH EPOXY GEL

A. High-Strength Epoxy Gel for crack surface sealing shall be **Denepox Rapidgel**, by **WR Grace/De Neef**, or equal.

PART 3 -- EXECUTION

3.1 GENERAL

A. Repairs

1. Repair techniques will be reviewed during the pre-construction meeting between the CONTRACTOR and ENGINEER.

2. The CONTRACTOR shall be familiar with the cause of deteriorated concrete and shall choose the right equipment, repair materials and techniques to be used for each particular repair.

3. Choose repair materials to match the adjacent concrete surface in color and texture.

4. Apply repair materials in strict accordance with the manufacturer's printed instructions, including temperature and moisture requirements throughout application and curing.

5. Protect adjacent portions of the structure, including all valves, pipes, mechanical equipment, and filter media from debris generated by repair activities.

6. For portions of the structure that are not identified to be repaired, maintain in their original condition.

B. Structural Stability

1. Use caution not to weaken the structural capacity of a beam, column, wall, slab, walkway, or other concrete member during concrete removal.

2. For severely deteriorated concrete members, consult with the ENGINEER before removing a major portion of any structural member.

3. Shoring may be required in order to support the structure and to protect workers.

C. Provide off-site disposal of debris generated as a result of repair procedures.

D. Provide concrete construction procedures not specifically addressed in this Section in accordance with the requirements of Section 03 31 00 – Cast-in-Place Concrete.

3.2 REPAIR SEQUENCING

A. Unless otherwise indicated, perform concrete repairs in the following sequence, with no activity in an area being started until previous activities in that area have been completed, including curing, cleanup, and the like:

1. removal of equipment, miscellaneous metals, and other surface features that would interfere with the repair;

2. removal of concrete sections which require complete replacement;

3. surface preparation hydroblasting over the entire area to be repaired;

4. embedded metal repair;

5. crack repair;

6. filter trough to wall connection repair;

7. spalled and delaminated concrete repair;

8. scaled concrete;

9. pop-out repair, and repair of other surface damage, deterioration, or defects;

10. patching of holes in concrete;

11. replacement of concrete sections which require complete replacement;

12. new construction;

13. application of protective coatings;

14. expansion joint repair; and,

15. installation of traffic topping.

B. For areas which require combinations of spalled and delaminated concrete repair, scaled concrete, and pop-out repair, perform these repairs at the same time.

C. Limit the size of the repair area in order to permit the repairs to be performed together, without sacrificing the quality of the individual repairs.

3.3 EMBEDDED METAL REPAIR

A. Unless otherwise indicated, repair anchor bolts and other embedded metal, except rebar, that are exposed at the concrete surface and are showing signs of corrosion, as follows:

1. Cut off or otherwise remove corroded metal fastened at the surface;

2. Burn back embedded metals to a depth of at least 1.5 inches beyond the surface of sound concrete;

3. Chip away unsound concrete around the embedded metal.

4. Apply epoxy grout to the repair area until level with the surface of the surrounding sound concrete.

B. Unless otherwise indicated, repair embedded rebar that is exposed at the concrete surface following the procedures outlined in the appropriate concrete repair subsection, below.

3.4 CRACK REPAIR

A. Structural Cracks - Structural Cracks are defined as follows:

1. All cracks where reinforcing steel is passing across the crack, including erratic cracks, and cracks at construction joints.

2. Repair structural cracks with epoxy resin.

B. Non Structural Cracks - Non Structural Cracks are defined as follows:

1. Cracks occurring at flexible joints, contraction joints or expansion joints.

2. Repair non-structural cracks with polyurethane chemical grout.

C. Efflorescence

1. Prior to the crack repair, clean efflorescence from the cracks and the surrounding area.

2. Clean the efflorescence by light hydro-blasting or scrubbing.

D. Pressure Injection: Pressure Injection to be performed prior to leak testing and roof membrane installation.

1. General

a. The indicated repair materials have been selected to minimize the loss of material during the injection process. The areas selected for crack repair are to be identified by the CONTRACTOR or ENGINEER and be determined prior to leak tests and roof membrane installation. The injection of cracks may also be required as a result of the leak test.

b. In order to avoid excessive loss of injected material at the lower exposed portions of the cracks, space the injection ports a distance no greater than the thickness of the wall being repaired.

2. Open through thickness structural cracks are to be repaired to deliver a water tight hydraulic structure passing the specified leakage test. All 3 foot long minimum or greater through thickness cracks greater than a minimum 15 mil thickness in the walls are to be injected unless they do not accept grout. All 2 foot long minimum through thickness cracks greater than 10 mil thickness in the foundation, water conduits, floor slabs and roof are to be injected unless they do not accept grout. Perform structural crack repairs by pressure injection in accordance with the manufacturer's directions, and in accordance with the following basic procedure:

a. Remove unsound and foreign materials from the crack in a manner that does not trap debris in the crack and prevent the flow of repair materials.

b. Remove any contamination by flushing with water or solvent, allowing adequate time for air-drying or blow out the solvent with compressed air. For potable water applications, any solvents must be fully flushed from the joint unless NSF/ANSI Standard 61 approved.

c. Install the injection ports in accordance with the manufacturer's directions.

d. Sealing

1) Seal the surface in order to keep the pressure injecting materials from leaking out before it has set or gelled.

2) Seal a surface by brushing an epoxy over the surface of the crack and allowing it to harden, or use high injection pressures to cut-out the cracks in a 'V' shape, fill with an epoxy, and strike off flush with the surface.

3) Surface patching or sealant shall be performed where needed to provide for complete penetration of the injected polyurethane grout and to prevent wastage. Seal surface of crack with fast setting hydraulic cement or high strength epoxy gel. The floor surface along the cracks shall be cleaned and all wasted grout and surface seal material shall be completely removed from the concrete surface following completion of the repair work

e. Inject the repair materials, with consideration of the following items:

1) Carefully select the pressure of the hydraulic pump or other device, because too much pressure can extend the existing cracks and cause more damage.

2) For vertical cracks, start by pumping material into the entry port at the lowest elevation until the material level reaches the entry port above, then cap the lower injection port and repeat the process at successively higher ports until the crack has been completely filled.

3) For horizontal cracks, start at one end of the crack and work to the other end, filling the crack until the pressure can be maintained.

4) For very fine cracks, start the injection of repair material at the widest end and proceed toward the thinner end, using low-viscosity repair material.

f. Cleanup

1) Remove the surface seal by grinding or other appropriate means.

2) Coat fittings and holes at injection ports with an epoxy patching compound.

3) If crack repairs are part of repair for surface defects, painting with epoxy is not necessary and surface preparation may be started after crack repairs have been completed.

3. Open through thickness non-structural cracks are to be repaired to deliver a water tight hydraulic structure passing the specified leakage test. Open through thickness cracks with lengths of at least 3 feet on each side of the wall and roof, at least 2 feet

of length on the foundation or floor slab are to be injected unless they do not accept grout. All 3 foot long minimum or greater through thickness cracks greater than a minimum 15 mil thickness in the walls are to be injected unless they do not accept grout. All 2 foot long through thickness cracks greater than 10 mil thickness in the floors and roof are to be injected unless they do not accept grout. Perform non-structural crack repairs in accordance with the manufacturer's directions, and in accordance with the following basic procedure:

a. Remove unsound and foreign materials from the crack in a manner that does not trap debris in the crack and prevent the flow of repair materials.

b. Remove contamination by flushing with water or solvent, allowing adequate time for air-drying or blow out the solvent with compressed air. Any solvents must be fully flushed from the joint unless NSF/ANSI Standard 61 approved.

c. Install the injection ports in accordance with the manufacturer's directions.

d. Moisture

    1) For non-structural cracks, moisture must be present for the chemical grout to react.

    2) Prior to injecting the repair materials, inject the crack with a small amount of water in order to completely moisten the crack.

e. Inject the repair materials, with consideration of the following items:

    1) Carefully select the pressure of the hydraulic pump or other device, because too much pressure can extend the existing cracks and cause more damage.

    2) For vertical cracks, start by pumping material into the entry port at the lowest elevation until the material level reaches the entry port above, cap the lower injection port and repeat the process at successively higher ports until the crack has been completely filled, and then, starting again at the lowest port, re-inject into all ports in order to ensure that all voids are properly sealed off.

    3) For horizontal cracks, start at one end of the crack and work to the other end, filling the crack until the pressure can be maintained.

    4) For very fine cracks, start the injection of repair material at the widest end and proceed toward the thinner end.

f. Cleanup

    1) Remove excess surface material by grinding or other appropriate means.

    2) Coat fittings and holes at injection ports with an epoxy patching compound.

    3) If crack repairs are part of repair for surface defects, painting with epoxy is not necessary and surface preparation may be started after crack repairs have been completed.

3.5 SPALLED AND DELAMINATED CONCRETE REPAIR

A. Repair spalls and delaminated concrete using repair mortar.

B. Surface Preparation

1. Remove all delaminated concrete and all unsound concrete beyond the spalled or delaminated area.

2. Boundaries

   a. Determine the boundaries of the patch by sawcuts to a depth of at least 1/4 inch up to one inch deep.

   b. Refer to the Structural Drawings for sawcut locations.

   c. Where the sawcut locations are not shown on the Drawings, the boundaries shall be layouts designed to reduce boundary edge length.

   d. Avoid excessive or complex edge conditions.

3. Sawcuts

   a. Perform sawcuts perpendicular to the surface or slightly undercut.

   b. Construct sawcuts in maximum 1/4-inch increments.

   c. After each incremental cut, inspect the cut surface in order to ensure that the existing reinforcement has not been cut.

   d. If at any depth the reinforcement becomes exposed, terminate the sawcut and notify the ENGINEER.

4. Chip away concrete within the repair area to a depth sufficient to expose sound concrete over the entire repair area, or to a minimum depth required by repair mortar, whichever is greater.

5. Base the selection of partial depth concrete removal equipment on the size of repair area, depth of concrete to be removed, and the location of the deteriorated concrete such as wall, slab-on-grade, underside or top of elevated slab.

6. Removal

   a. The maximum allowable pneumatic chipping hammer shall be a 30-lb class hammer.

   b. Hydroblast removal shall use a maximum pressure of 40,000 psig.

   c. Sand blasting is not permitted.

   d. Hydroblast concrete removal is recommended for large area of surface defects.

   e. Remove water blasting debris daily in order to prevent it from setting up.

f. If a chipping hammer is used, ensure that the existing reinforcement is not damaged during the concrete removal operations.

g. Remove protrusions, such as mortar spatter or fins, by grinding or by striking with a hammer or other tool.

7. Reinforcement

a. Remove concrete from around reinforcement when the rebar is rusted, more than half the rebar perimeter is already exposed, the concrete bond around the rebar is broken, or if the concrete is unsound or honey-combed.

b. Remove concrete in order to provide a clear space of minimum one inch on all sides of the reinforcement, such that the rebar can be cleaned, and the repair material will completely surround the rebar.

c. Clean exposed reinforcement by water blasting or wire brushing.

d. After fully exposing and cleaning the reinforcement, check for steel deterioration, and if the cross-sectional area of the steel has been reduced by more than 10 percent, whether by deterioration, surface preparation, or a combination of both, provide additional reinforcement.

e. Consult with the ENGINEER before adding or replacing rebar.

C. Repairing Surface Defects

1. Clean the concrete surface after removing unsound concrete, repairing cracks, and cleaning the reinforcement.

2. Ensure that the concrete surface and reinforcement are free of form-release agents, curing compounds, surface hardeners, oils, grease, food, chemicals, and other contaminants.

3. Remove dust, including new dust generated by surface preparation or scarifying.

4. Prior to application of the bonding agent, apply anti-corrosion coating to exposed rebar in accordance with the manufacturer's recommendations, allow the coating to dry, reapply the coating, and allow to dry again.

5. Prior to applying the repair mortar, apply bonding agent in accordance with the manufacturer's recommendations.

6. Repair Mortar

a. Apply repair mortar in accordance with the manufacturer's recommendations.

b. The thickness of each lift of repair mortar shall be in accordance with the manufacturer's recommendations, with the minimum thickness being not less than 1/4 inch.

7. Fully consolidate the repair mortar, working the material into the substrate to completely fill all pores and voids in the area to be filled.

8. Bring the repair surface into alignment with the adjacent existing surfaces in order to provide a uniform, even surface.

9. Match the repair surface to adjacent existing surfaces in texture by applying necessary coatings and surface treatments.

10. Float-finish the repaired surface using wood or sponge floats.

11. For repaired surfaces to receive a protective coating, brush-finish the surface in order to produce a roughened substrate for the coating.

12. Minimum and maximum ambient and surface temperatures shall be as recommended by repair material manufacturer.

D. Curing

1. Curing of repair mortar to receive waterproofing shall be as follows:

a. Keep the mortar continuously wet by the application of water for a minimum period of at least 7 consecutive days, beginning immediately after the mortar has reached final set;

b. Weight the curing blankets or otherwise held them in place in order to prevent being dislodged by wind or other causes, and to be substantially in contact with the concrete surface;

c. Ensure that edges are continuously held in place; and,

d. Keep the curing blankets and concrete continuously wet by the use of sprinklers or other means, both during and after normal working hours.

2. If the repair mortar is not to receive waterproofing, provide curing in accordance with the manufacturer's recommendations except that the minimum cure period shall be 7 days.

3. During cold weather, maintain the repair material temperature above 50 degrees F for at least 3 days after placement.

3.6 SCALED CONCRETE REPAIR

A. Repair scaling and pop-outs using repair mortar.

B. Surface Preparation

1. Prior to repair, prepare the surface in accordance with the repair mortar manufacturer's recommendations with the following minimum requirement.

2. Remove unsound concrete from surfaces by high-pressure water blasting, using a minimum pressure of 10,000 psigg and maximum pressure of 40,000 psigg.

3. Clean exposed reinforcement by water blasting or wire brushing.

C. Repairing Surface Defects

1. Clean the concrete surface after removing unsound concrete, repairing cracks, and cleaning reinforcement.

2. Ensure that the concrete surface and reinforcement are free of form-release agents, curing compounds, surface hardeners, oils, grease, food, chemicals, and other contaminants.

3. Remove dust, including new dust generated by surface preparation or scarifying.

4. Prior to application of the bonding agent, apply anti-corrosion coating to exposed rebar in accordance with the manufacturer's recommendations, allow the coating to dry, reapply the coating, and allow to dry again.

5. Prior to applying the repair mortar, apply bonding agent in accordance with the manufacturer's recommendations.

6. Apply repair mortar in accordance with the manufacturer's recommendations, using a minimum repair material thickness of 1/4 inch.

7. Fully consolidate the repair material, working the material into the substrate to completely fill all pores and voids in the area to be filled.

8. Bring the repair surface into alignment with the adjacent existing surfaces in order to provide a uniform, even surface.

9. Match the repair surface to adjacent existing surfaces in texture by applying necessary coatings and surface treatments.

10. Float-finish the repaired surface using wood or sponge floats.

D. Provide strip joint in newly placed mortar at the location of repaired cracks.

E. Curing

1. Curing of repair mortar to receive waterproofing shall be as follows:

   a. Keep the mortar continuously wet by the application of water for a minimum period of at least 7 consecutive days, beginning immediately after the mortar has reached final set;

   b. Weight the curing blankets or otherwise held them in place in order to prevent being dislodged by wind or other causes, and to be substantially in contact with the concrete surface;

   c. Ensure that edges are continuously held in place; and,

   d. Keep the curing blankets and concrete continuously wet by the use of sprinklers or other means, both during and after normal working hours.

2. If the repair mortar is not to receive waterproofing, provide curing in accordance with the manufacturer's recommendations except that the minimum cure period shall be 7 days.

3. During cold weather, maintain the repair material temperature above 50 degrees F for at least 3 days after placement.

3.7 POP-OUT REPAIR, AND REPAIR OF OTHER SURFACE DAMAGE, DETERIORATION, OR DEFECTS

A. Repair pop-outs and other surface damage, deterioration, and defects which are 1/4 inch deep or shallower, using the procedures described under "SCALED CONCRETE REPAIR," above.

B. Repair other pop-outs and surface damage, deterioration, and defects using the procedures described under "SPALLED AND DELAMINATED CONCRETE REPAIR," above.

3.8 REPLACEMENT OF CONCRETE SECTIONS WHICH REQUIRE COMPLETE REPLACEMENT

A. Refer to the Structural Drawings for locations where the level of concrete deterioration is such that complete removal and replacement of the deteriorated section is required.

B. At these locations, remove the deteriorated concrete in accordance with the details on the Structural Drawings and the requirements of this Section.

C. Limits

1. The limits of concrete removal shall be as indicated on the Structural Drawings.

2. If no limits of removal are indicated, determine the limits in accordance with the procedures described under “Boundaries – Spalled and Delaminated Concrete Repair.”

D. Provide sawcuts in accordance with the procedures described under “Sawcuts – Spalled and Deliminated Concrete Repair.”

E. After removal of the concrete, prepare the area and provide repair concrete in accordance with the details on the Structural Drawings and the requirements of this Section.

F. Unless otherwise indicated, match the finished cross-section of the repaired concrete to the cross-section of the adjacent undamaged concrete.

3.9 PATCHING OF HOLES IN CONCRETE

A. General

1. For the purposes of this Section, holes are defined as penetrations completely through the concrete member and with interior surfaces approximately perpendicular to the surface of the existing member.

2. Interior surface areas which are inclined and do not meet these criteria shall be chipped as needed to meet this requirement.

3. The perimeter of holes at the surface shall form a regular shape composed of curved or straight line segments.

4. Provide the minimum depth of placement for the material used; score the existing concrete by sawcutting, and chip as needed to meet this requirement.

5. Roughen the interior surface of holes less than 12 inches in diameter to a minimum of 0.125-inch amplitude and roughen larger holes to a minimum of 0.25-inch amplitude.

6. At holes, coat the existing surface to be repaired with a bonding agent.

B. Patching Small Holes: For holes which are less than 12 inches in their least dimension and extend completely through concrete members, fill with non-shrink grout.

C. Patching Large Holes

1. Fill holes which are larger than 12 inches in their least dimension with structural repair grout.

2. Provide large holes which are normally in contact with water or soil with hydrophilic waterstop placed in a groove.

3. Alternatively, bond the hydrophilic waterstop to the surface using an epoxy grout which completely fills all voids and irregularities beneath the waterstop material.

4. Install the waterstop in accordance with the requirements of Section 03 32 00 – Joints in Concrete.

5. Provide reinforcing steel in layers matching existing reinforcement location, size, spacing and cover requirements unless directed otherwise by the ENGINEER.

6. In locations where NSF/ANSI Standard 61 approval is required by the authority having jurisdiction, use one of the following procedures:

a. Provide Product Data showing the proposed structural repair grout is NSF/ANSI Standard 61 approved.

b. Complete the repair with structural repair grout. Coat all surfaces required to have NSF/ANSI Standard 61 approval completely with Sikadur 31, Tyfo S, or equal.

c. Place the structural repair grout to within 1 ½" of the finished surface of the repair. Complete the remainder of the repair with SikaTop123 Plus, or equal.

3.10 PATCHING OF LINED HOLES

A. General

1. This WORK applies to those openings which have embedded material over all or a portion of their inside edge.

2. The requirements for repairing holes in concrete, as indicated above, apply as modified herein.

3. The COT will determine whether the embedded material is allowed to remain.

B. Where embedded material is allowed to remain, trim it back a minimum of 2 inches from the concrete surface.

C. Roughen or abrade the embedded material in order to promote good bonding to the repair material.

D. Remove substances that interfere with good bonding.

E. Completely remove embedded items that are not securely and permanently anchored into the concrete.

F. Completely remove embedded items which are larger than 12 inches in their least dimension, unless they are composed of a metal to which reinforcing steel can be welded; where reinforcement is required, weld it to the embedded metal.

G. The following requirements shall apply to concrete members which are in contact with water or soil:

1. Using epoxy grout, fill lined openings which are less than 4 inches in their least dimension;

2. Using an epoxy bonding agent, coat lined openings which are greater than 4 inches but less than 12 inches in their least dimension, prior to being filled with non-shrink grout.

3. Using an epoxy bonding agent, coat lined openings which are greater than 12 inches in their least dimension and provide a hydrophilic waterstop bonded to the interior of the opening with epoxy adhesive, prior to being filled with approved repair material.

3.11 APPLICATION OF PROTECTIVE COATINGS

A. Waterproofing

1. Apply waterproofing in accordance with the manufacturer's printed instructions.

2. Do not begin waterproofing WORK until repairs and new construction in the affected area have been completed and adequately cured.

3.12 EXPANSION JOINT REPAIR

A. Repair deteriorated expansion joints as follows:

1. Completely remove existing sealant;
2. Remove defective backer materials in the joint;
3. Sand-blast the joint and prepare the surface in accordance with the sealant manufacturer's instructions;
4. Prepare the wall surface on each side of the joint in accordance with the expansion joint manufacturer's instructions;
5. Ensure that the prepared surface is clean, sound, and bare concrete;
6. Place backer material in the joint;
7. Apply a primer recommended by the sealant manufacturer;
8. Fill the joint with polyurethane sealant;
9. Allow a minimum of 3 days curing prior to installing the expansion joint; and,
10. Install the expansion joint in accordance with the manufacturer's instructions.

END OF SECTION

SECTION 03 11 00 - CONCRETE FORMING

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall furnish concrete formwork, bracing, shoring, and supports for cast-in-place concrete and shall design and construct falsework, all in accordance with the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Contractor Submittals.

B. Manufacturer's information demonstrating compliance with requirements for the following:

1. Form ties and related accessories, including taper tie plugs, if taper ties are used.

2. Form gaskets.

3. Form release agent, including NSF certification if not using mineral oil.

4. Manufacturer's information on formwork, form materials, and locations for use.

C. **Shop Drawings:** Detailed plans for the fabrication and erection of falsework to be used. Such plans shall be in sufficient detail to indicate the general layout, sizes of members, anticipated stresses, grade of materials to be used in the falsework, means of protecting existing construction which supports falsework, and typical soil conditions. Include a list of form materials and locations for use.

D. Falsework Calculations and Drawings: All falsework or vertical shoring installations where the height of the falsework or vertical shoring, as measured from the top of the sills to the soffit of the superstructure, exceeds 14-feet, or where individual horizontal span lengths exceed 16-feet, or provision for vehicular or railroad traffic through falsework or vertical shoring is made, shall be approved and signed by a civil engineer, registered in the State of Washington; provided further, that a copy of the falsework plan or shoring layout shall be available on the Site at all times.

1.3 QUALITY ASSURANCE

A. **Tolerances:** Tolerances shall be in accordance with Section 03 31 00 – Cast-in-Place Concrete. Other tolerances shall be within the tolerances of ACI 117 - Standard Tolerances for Concrete Construction and Materials

PART 2 -- PRODUCTS

2.1 GENERAL

A. Forms shall be smooth surface forms and shall be of the following materials:

Walls	Steel, fiberglass, or plywood panel
Columns	Steel, plywood or fiberglass
Roof and floor	Plywood
All other WORK	Steel panels, fiberglass, plywood or tongue and groove lumber

B. Form materials that may remain or leave residues on or in the concrete shall be certified as compliant with NSF Standard 61 – Drinking Water System Components.

C. Water-based form release agent shall be **Clean Strip J1EF** by **Dayton Superior**, or equal.

2.2 FORM AND FALSEWORK MATERIALS

A. Materials for concrete forms, formwork, and falsework shall conform to the following requirements:

1. Lumber shall be Douglas Fir or Southern Yellow Pine, construction grade or better, in conformance with U.S. Product Standard PS 20 - American Softwood Lumber Standard

2. Plywood for concrete formwork shall be new, waterproof, synthetic resin bonded, exterior type Douglas Fir or Southern Yellow Pine plywood manufactured especially for concrete formwork, shall conform to the requirements of PS 1 – Construction and Industrial Plywood, for Concrete Forms, Class I, and shall be edge sealed.

3. Form materials shall be metal, wood, plywood, or other material that will not adversely affect the concrete and will facilitate placement of concrete to the shape, form, line, and grade indicated. Metal forms shall accomplish such results. Wood forms for surfaces to be painted shall be Medium Density Overlaid plywood, MDO Ext. Grade.

4. Steel leave in place forms shall not be used.

B. Unless otherwise indicated, exterior corners in concrete members shall be provided with 3/4-inch chamfers or be tooled to 1/2-inch radius. Re-entrant corners in concrete members shall not have fillets unless otherwise indicated.

C. Forms and falsework to support the roof and floor slabs shall be designed for the total dead load, plus a live load of 50 psf minimum. The minimum design load for combined dead and live loads shall be 100 psf.

2.3 FORM TIES

A. Form ties shall be provided with a plastic cone or other suitable means for forming a conical hole to ensure that the form tie may be broken off back of the face of the concrete. The maximum diameter of removable cones for rod ties or other removable form tie fasteners having a circular cross-section shall not exceed 1-1/2 inches; and all such fasteners shall be such as to leave holes of regular shape for reaming. Form ties

for water-retaining structures shall have integral waterstops that tightly fit the form tie so that they cannot be moved from mid-point of the tie. Form ties shall be **ST-4 Hex Head Snap Tie** by **MeadowBurke, Snap-Ties** by **Dayton/Richmond,** or equal.

B. Removable taper ties may be used when approved by the ENGINEER. A preformed neoprene or polyurethane tapered plug sized to seat at the center of the wall shall be inserted in the hole left by the removal of the taper tie**.** Use **HD-9 Taper-Tie** by **Meadow Burke, Taper-Tie** by **Dayton/Richmond,** or equal.

PART 3 -- EXECUTION

3.1 GENERAL

A. Forms to confine the concrete and shape it to the required lines shall be used wherever necessary. The CONTRACTOR shall assume full responsibility for the adequate design of forms, and any forms that are unsafe or inadequate in any respect shall promptly be removed from the WORK and replaced. Provide worker protection from protruding reinforcement bars in accordance with applicable safety codes. A sufficient number of forms of each kind shall be available to permit the required rate of progress to be maintained. The design and inspection of concrete forms, falsework, and shoring shall comply with applicable local, state, and Federal regulations. Plumb and string lines shall be installed before concrete placement and shall be maintained during placement. Such lines shall be used by CONTRACTOR's personnel and by the ENGINEER and shall be in sufficient number and properly installed. During concrete placement, the CONTRACTOR shall continually monitor plumb and string line form positions and immediately correct deficiencies.

B. Concrete forms shall conform to the shape, lines, and dimensions of members required, and shall be substantial, free from surface defects, and sufficiently tight to prevent leakage. Forms shall be properly braced or tied together to maintain their position and shape under a load of freshly placed concrete. If adequate foundation for shores cannot be secured, trussed supports shall be provided.

C. Forms shall be removed unless approved otherwise by the ENGINEER.

3.2 FORM DESIGN

A. Forms shall be true in every respect to the required shape and size, shall conform to the established alignment and grade, and shall be of sufficient strength and rigidity to maintain their position and shape under the loads and operations incident to placing and vibrating the concrete. Suitable and effective means shall be provided on forms for holding adjacent edges and ends of panels and sections tightly together and in accurate alignment so as to prevent the formation of ridges, fins, offsets, or similar surface defects in the finished concrete. Plywood, 5/8-inch and greater in thickness, may be fastened directly to studding if the studs are spaced close enough to prevent visible deflection marks in the concrete. The forms shall be tight so as to prevent the loss of water, cement, and fines during placing and vibrating of the concrete. Specifically, the bottom of wall forms that rest on concrete footings or slabs shall be provided with a gasket to prevent loss of fines and paste during placement and vibration of concrete. Such gasket may be a 1- to 1-1/2-inch diameter polyethylene rod held in position to the underside of the wall form. Adequate clean-out holes shall be provided at the bottom of each lift of forms. The size, number, and location of such clean-outs shall be as acceptable to the ENGINEER. Whenever concrete cannot be placed from the top of a wall form in a

manner that meets the requirements of the Contract Documents, form windows shall be provided in the size and spacing needed to allow placement of concrete to the requirements of Section 03 31 00 - Cast-in-Place Concrete. The size, number, and location of such form windows shall be as acceptable to the ENGINEER.

3.3 CONSTRUCTION

A. **Vertical Surfaces:** Vertical surfaces of concrete members shall be formed, except where placement of the concrete against the ground is indicated. Not less than 1-inch of concrete shall be added to the indicated thickness of a concrete member where concrete is permitted to be placed against trimmed ground in lieu of forms. Permission to do this on other concrete members will be granted only for members of comparatively limited height and where the character of the ground is such that it can be trimmed to the required lines and will stand securely without caving or sloughing until the concrete has been placed.

B. **Construction Joints:** Concrete construction joints will not be permitted at locations other than those indicated, except as may be acceptable to the ENGINEER. When a second lift is placed on hardened concrete, special precautions shall be taken in the way of the number, location, and tightening of ties at the top of the old lift and bottom of the new to prevent any unsatisfactory effect whatsoever on the concrete. Pipe stubs and anchor bolts shall be set in the forms where required.

C. Form Ties

1. Embedded Ties: Holes left by the removal of form tie cones shall be reamed with suitable toothed reamers so as to leave the surface of the holes clean and rough before being filled with mortar. Wire ties for holding forms will not be permitted. No form-tying device or part thereof, other than metal, shall be left embedded in the concrete. Ties shall not be removed in such manner as to leave a hole extending through the interior of the concrete members. The use of snap-ties that cause spalling of the concrete upon form stripping or tie removal will not be permitted. If steel panel forms are used, rubber grommets shall be provided where the ties pass through the form in order to prevent loss of cement paste. Where metal rods extending through the concrete are used to support or to strengthen forms, the rods shall remain embedded and shall terminate not less than 1-inch back from the formed face or faces of the concrete.

2. Removable Ties: Where taper ties are approved for use, the larger end of the taper tie shall be on the wet side of walls in water retaining structures. After the taper tie is removed, the hole shall be thoroughly cleaned and roughened for bond. A precast neoprene or polyurethane tapered plug shall be located at the wall centerline. The hole shall be completely filled with non-shrink grout for water bearing and below-grade walls. The hole shall be completely filled with non-shrink or regular cement grout for above-grade walls that are dry on both sides. Exposed faces of walls shall have the outer 2-inches of the exposed face filled with a cement grout that shall match the color and texture of the surrounding wall surface.

3.4 REUSE OF FORMS

A. Forms may be reused only if in good condition and only if acceptable to the ENGINEER. Light sanding between uses will be required wherever necessary to obtain uniform surface texture on exposed concrete surfaces. Exposed concrete surfaces are defined

as surfaces which are permanently exposed to view. In the case of forms for the inside wall surfaces of hydraulic/water retaining structures, unused tie rod holes in forms shall be covered with metal caps or shall be filled by other methods acceptable to the ENGINEER.

3.5 REMOVAL OF FORMS

A. Careful procedures for the removal of forms shall be strictly followed, and this WORK shall be done with care so as to avoid injury to the concrete. No heavy loading on green concrete will be permitted. In the case of roof slabs and above-ground floor slabs, forms shall remain in place until test cylinders for the roof concrete attain a minimum compressive strength of 75 percent of the 28 Day strength in Section 03 31 00. No forms shall be disturbed or removed under an individual panel or unit before the concrete in the adjacent panel or unit has attained 75 percent of the 28 Day strength and has been in place for a minimum of 7 Days. The time required to establish said strength shall be as determined by the ENGINEER who will make several test cylinders for this purpose from concrete used in the first group of roof panels placed. If the time so determined is more than the 7 Day minimum, then that time shall be used as the minimum length of time. Forms for vertical walls of water holding structures shall remain in place at least 36 hours after the concrete has been placed. Forms for parts of the WORK not specifically mentioned herein shall remain in place for periods of time as recommended in ACI 347 - Guide to Formwork for Concrete.

3.6 MAINTENANCE OF FORMS

A. Forms shall be maintained in good condition, particularly as to size, shape, strength, rigidity, tightness, and smoothness of surface. Before concrete is placed, the forms shall be thoroughly cleaned. The form surfaces shall be treated with a non-staining mineral oil or other lubricant acceptable to the ENGINEER. Any excess lubricant shall be satisfactorily removed before placing the concrete. Where field oiling of forms is required, the CONTRACTOR shall perform the oiling at least 2 weeks in advance of their use. Care shall be exercised to keep oil off the surfaces of steel reinforcement and other metal items to be embedded in concrete.

3.7 FALSEWORK

A. The CONTRACTOR shall be responsible for the design, engineering, construction, maintenance, and safety of falsework, including staging, walkways, forms, ladders, and similar appurtenances, which shall equal or exceed the applicable requirements of the provisions of the OSHA Safety and Health Standards for Construction, the requirements of the Construction Safety Orders of the California Division of Industrial Safety, and the requirements herein.

B. Falsework shall be designed and constructed to provide the necessary rigidity and to support the loads. Falsework for the support of a superstructure shall be designed to support the loads that would be imposed if the entire superstructure were placed at one time.

C. Falsework shall be placed upon a solid footing, safe against undermining, and be protected from softening. When the falsework is supported on timber piles, the maximum calculated pile loading shall not exceed 20 tons. When falsework is supported on any portion of the structure which is already constructed, the load imposed by the falsework

shall be spread, distributed, and braced in such a way as to avoid any possibility of damage to the structure.

END OF SECTION

SECTION 03 21 00 - REINFORCEMENT STEEL

1.1 THE SUMMARY

A. Provide reinforcement steel and appurtenant WORK, complete and in place, in accordance with the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals.

B. Shop Drawings

1. Furnish shop bending diagrams, placing lists, and drawings of reinforcement steel prior to fabrication.

2. Diagrams

a. The shop bending diagrams shall show the actual lengths of bars to the nearest inch, measured to the intersection of the extensions (tangents for bars of circular cross section) of the outside surface.

b. Include bar placement diagrams that clearly indicate the dimensions of each bar splice.

3. Reinforcement

a. Details of the concrete reinforcement steel and concrete inserts shall be submitted at the earliest possible date after receipt by the CONTRACTOR of the Notice to Proceed.

b. Said details of reinforcement steel for fabrication and erection shall conform to ACI 315 - Details and Detailing of Concrete Reinforcement, and the indicated requirements.

4. Mechanical Couplers

a. Where mechanical couplers are required or permitted to be used to splice reinforcement steel, submit the following items:

1) manufacturer's literature containing instructions and recommendations for installation for each type of coupler.

2) certified test reports that verify the load capacity of each type and size of coupler used.

3) Shop Drawings that show the location of each coupler with details of how they are to be installed in the formwork.

1.3 QUALITY ASSURANCE

A. Materials Testing

1. If requested by the ENGINEER, furnish samples from each heat of reinforcement steel in a quantity adequate for testing.

2. Costs of initial tests will be paid by the OWNER.

3. Costs of additional tests if material fails initial tests shall be the CONTRACTOR's responsibility.

PART 2 -- PRODUCTS

2.1 MATERIAL REQUIREMENTS

A. Materials that may remain or leave residues on or within the concrete shall be certified as compliant with NSF Standard 61- Drinking Water System Components.

2.2 REINFORCEMENT STEEL

A. Reinforcement steel for cast-in-place reinforced concrete construction shall conform to the following requirements:

1. Bar and spiral reinforcement shall conform to ASTM A 615 - Deformed and Plain Carbon – Steel Bars for Concrete Reinforcement, for Grade 60 reinforcement, unless otherwise indicated.

2. Welded Wire Reinforcement

a. Welded wire reinforcement shall conform to ASTM A1064 - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete, and the indicated Details.

b. Welded wire reinforcement with longitudinal wire of W4 size wire and smaller shall be in flat sheets or in rolls with a core diameter of not less than 10-inches.

c. Welded wire reinforcement with longitudinal wires larger than W4 size shall be in flat sheets only.

B. Accessories

1. Accessories shall include necessary chairs, slab bolsters, concrete blocks, tie wires, dips, supports, spacers, and other devices to position reinforcement during concrete placement.

2. Bar Supports

a. Bar supports shall meet the requirements of the CRSI Manual of Standard Practice, including special requirements for supporting epoxy-coated reinforcing bars.

b. Wire bar supports shall be CRSI Class 1 for maximum protection with a 1/8-inch minimum thickness of plastic coating that extends at least 1/2 inch from the concrete surface.

c. Plastic shall be gray in color.

3. Concrete Blocks

a. Concrete blocks (dobies) used to support and position reinforcement steel shall have the same or higher compressive strength as required for the concrete in which they are located.

b. Wire ties shall be embedded in concrete block bar supports.

C. Epoxy coating for reinforcing and accessories, where indicated, shall conform to ASTM A 775 - Epoxy - Coated Reinforcing Steel Bars.

2.3 MECHANICAL COUPLERS

A. Mechanical couplers shall be provided where indicated and where approved by the ENGINEER.

B. The couplers shall develop a tensile strength that exceeds 125 percent of the yield strength of the reinforcement bars being spliced at each splice.

C. Multi-Component Couplers

1. Where the type of coupler used is composed of more than one component, components required for a complete splice shall be provided.

2. This shall apply to mechanical splices, including those splices intended for future connections.

D. Connection

1. The reinforcement steel and coupler used shall be compatible for obtaining the required strength of the connection.

2. Straight threaded type couplers shall require the use of the next larger size reinforcing bar or shall be used with reinforcing bars with specially forged ends which provide upset threads which do not decrease the basic cross section of the bar.

E. Couplers shall be **Lenton Form Saver** by **Erico Products, Dowel Bar Splicer System** by **Dayton/Richmond**, or equal.

2.4 EPOXY GROUT

A. Epoxy for grouting shall conform to ASTM C881 - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete, and the indicated details.

B. Epoxy for grouting reinforcing bars shall be specifically formulated for such application, for the moisture condition, application temperature, and orientation of the hole to be filled.

C. Epoxy grout shall be in conformance with the requirements of Section 03 60 00 – Grouting.

PART 3 -- EXECUTION

3.1 GENERAL

A. Reinforcement steel, welded wire fabric, couplers, and other appurtenances shall be fabricated, and placed in accordance with the Building Code and the indicated supplementary requirements.

3.2 FABRICATION

A. General

1. Reinforcement steel shall be accurately formed to the dimensions and shapes indicated, and the fabricating details shall be prepared in accordance with ACI 315 and ACI 318 - Building Code Requirements for Reinforced Concrete, except as modified by the Drawings.

2. Bars shall be bent cold.

3. Bars shall be bent in accordance with the requirements of ACI 318.

4. Fabricate reinforcement bars for structures in accordance with accepted bending diagrams, placing lists, and placing drawings.

B. Fabricating Tolerances

1. Bars used for concrete reinforcement shall conform to the following fabricating tolerances:

a. Sheared Length: plus and minus one inch

b. Depth of Truss Bars: plus zero, minus 1/2 inch

c. Stirrups, Ties and Spirals: plus and minus 1/2 inch

d. Other Bends: plus and minus one inch

3.3 PLACEMENT

A. Reinforcement steel shall be accurately positioned as indicated and shall be supported and wired together to prevent displacement using annealed iron wire ties or suitable clips at intersections.

B. Reinforcement steel shall be supported by concrete, plastic or metal support spacers, or metal hangers that are sufficiently strong and rigid to prevent any displacement of the reinforcement steel.

C. Where concrete is to be placed on the ground, supporting concrete blocks (or dobies) shall be used in sufficient numbers to support the bars without settlement, but in no case shall such support be continuous.

D. Concrete blocks used to support reinforcement steel shall be tied to the steel with wire ties that are embedded in the blocks.

E. For concrete over formwork, provide concrete, metal, plastic, or other acceptable bar chairs and spacers.

F. Limitations on the use of bar support materials shall be as follows.

1. Concrete Dobies

a. permitted at any location except where architectural finish is required.

b. required for slabs on grade and surfaces in contact with or above ozonated process water.

2. Wire bar supports will be permitted only at slabs over dry areas, interior dry wall surfaces, and exterior wall surfaces.

3. Plastic bar supports will be permitted at every location except on-grade.

G. Tie wires shall be bent away from the forms in order to provide the required concrete coverage.

H. Bars additional to those indicated that may be found necessary or desirable by the CONTRACTOR for the purpose of securing reinforcement in position shall be provided by the CONTRACTOR at no additional expense to the OWNER.

I. Except where in conflict with the Building Code, unless otherwise indicated reinforcement placing tolerances shall be within the limits in Section 26.6.2 of ACI 318.

J. Moving Bars

1. Bars may be moved as necessary to avoid interference with other reinforcement steel, conduits, or embedded items.

2. If bars are moved more than one bar diameter or enough to exceed the above tolerances, the resulting arrangement of bars shall be as reviewed and accepted by the ENGINEER.

K. Welded Wire Reinforcement

1. Welded wire reinforcement placed over horizontal forms shall be supported on slab bolsters.

2. Slab bolsters shall be spaced not more than 30-inch on centers, shall extend continuously across the entire width of the reinforcement mat, and shall support the reinforcement mat in the plane indicated.

3. Welded wire reinforcement placed over the ground shall be supported on wired concrete blocks (dobies) spaced not more than 3 feet on centers in any direction.

4. The construction practice of placing welded wire fabric on the ground and hooking into place in the freshly placed concrete shall not be used.

L. Storage and Handling

1. Epoxy-coated reinforcing bars shall be stored, transported, and placed in such a manner as to avoid chipping of the epoxy coating.

2. Non-abrasive slings made of nylon and similar materials shall be used.

3. Specially coated bar supports shall be used.

4. Chips or cracks in the epoxy coating shall be repaired with a compatible epoxy repair material prior to placing concrete.

M. Accessory Spacing

1. Accessories supporting reinforcing bars shall be spaced such that there is no deflection of the accessory from the weight of the supported bars.

2. When used to space the reinforcing bars from wall forms, the forms and bars shall be located such that there is no deflection of the accessory when the forms are tightened into position.

3.4 SPACING OF BARS

A. The clear distance between parallel bars (except in columns and between multiple layers of bars in beams) shall be not less than the nominal diameter of the bars, nor less than 1-1/3 times the maximum size of the coarse aggregate, nor less than one inch.

B. Where reinforcement in beams or girders is placed in 2 or more layers, the clear distance between layers shall be not less than one inch, and reinforcement in the upper layers shall be placed directly above reinforcement in the bottom layer.

C. In columns, the clear distance between longitudinal bars shall be not less than 1-1/2 times the bar diameter, nor less than 1-1/3 times the maximum size of the coarse aggregate, nor less than 1-1/2 inches.

D. The clear distance between bars shall also apply to the distance between a contact splice and adjacent splices or bars.

3.5 SPLICING

A. General

1. Reinforcement bar splices shall only be used at indicated locations.

2. When it is necessary to splice reinforcement at points other than where indicated, the character of the splice shall be as reviewed and accepted by the ENGINEER.

3. Unless otherwise indicated, dowels shall match the size and spacing of the spliced bar.

B. Splices of Reinforcement

1. The length of lap for reinforcement bars, unless otherwise indicated, shall be in accordance with ACI 318, Section 25.5.2.1 for a Class B splice.

2. Welded Wire Reinforcement

a. Laps of welded wire reinforcement shall be in accordance with ACI 318.

b. Adjoining sheets shall be securely tied together with No. 14 tie wire, one tie for each 2 running feet.

c. Wires shall be staggered and tied in such a manner that they cannot slip.

3. Splices in column spiral reinforcement, when necessary, shall be made by welding or by a lap of 1-1/2 turns.

C. Bending or Straightening

1. Reinforcement shall not be straightened or re-bent in a manner which will injure the material.

2. Bars shall be bent or straight as indicated.

3. Do not use bends different from the bends indicated.

4. Bars shall be bent cold, unless otherwise permitted by the ENGINEER.

5. No bars partially embedded in concrete shall be field-bent except as indicated or specifically permitted by the ENGINEER.

D. Couplers

1. Couplers that are located at a joint face shall be of a type that can be set either flush or recessed from the face as indicated.

2. The couplers shall be sealed during concrete placement to completely eliminate concrete or cement paste from entering.

E. Unless indicated otherwise, mechanical coupler spacing, and capacity shall match the spacing and capacity of the reinforcing indicated for the adjacent section.

3.6 CLEANING AND PROTECTION

A. Reinforcement steel shall always be protected from conditions conducive to corrosion until concrete has been placed around it.

B. The surfaces of reinforcement steel and other metalwork to be in contact with concrete shall be thoroughly cleaned of dirt, grease, loose scale and rust, grout, mortar, and other foreign substances immediately before the concrete is placed.

C. Where there is delay in depositing concrete, the reinforcement shall be re-inspected and, if necessary, re-cleaned.

3.7 EMBEDMENT OF DRILLED REINFORCING STEEL DOWELS

A. Hole Preparation

1. The hole diameter shall be as recommended by the epoxy manufacturer but shall be no larger than 1/4 inch greater than the diameter of the outer surface of the reinforcing bar deformations.

2. The depth of the hole shall be as recommended by the epoxy manufacturer to fully develop the bar but shall not be less than 12 bar diameters, unless indicated otherwise.

3. The hole shall be drilled by methods that do not interfere with the proper bonding of epoxy.

4. Existing reinforcing steel in the vicinity of proposed holes shall be located prior to drilling, and the location of holes shall be adjusted to avoid drilling through or nicking any existing reinforcing bars.

5. The hole shall be blown clean with clean, dry compressed air to remove dust and loose particles.

B. Embedment

1. Epoxy shall be injected into the hole through a tube placed to the bottom of the hole.

2. The tube shall be withdrawn as epoxy is placed but kept immersed to prevent formation of air pockets.

3. The hole shall be filled to a depth that ensures excess material will be expelled from the hole during dowel placement.

4. Dowels shall be twisted during insertion into the partially filled hole so as to guarantee full wetting of the bar surface with epoxy.

5. The bar shall be inserted slowly enough to avoid developing air pockets.

END OF SECTION

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SECTION 03 30 10 – CONTROLLED DENSITY FILL (CDF)

PART 1 --GENERAL

1.1 SUMMARY

A. This Section specifies high slump concrete slurry for pipe bedding and trench backfill purposes and for fill of decommissioned buried pipes.

B. Purpose: The main intent of specifying the use of concrete slurry for bedding material is to ensure the placement and consolidation of materials under the haunch of the pipe and to maintain the slope and elevations shown on the Drawings. The fluidity and workability of the concrete slurry is therefore of principal concern. The main intent of specifying CDF for trenchbackfill is to protect the pipe from traffic loading due to shallow burial depths.

1.2 REFERENCED STANDARDS

A. This Section incorporates by reference the latest revisions of the following embedded standards referenced herein. In case of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

REFERENCE	TITLE
ASTM C150	Specification for Portland Cement
ASTM C260	Specification for Air-Entraining Admixtures for Concrete
ASTM C595	Standard Specification for Blended Hydraulic Cements
ASTM C618	Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete
ASTM C989	Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C33	Standard Specification for Concrete Aggregates
ASTM C494	Standard Specification for Chemical Admixtures for Concrete
ACI 229R-13	Report on Controlled Low-Strength Materials

1.3 SUBMITTALS

A. Procedure: 01 33 00

B. Mix Design.

C. On a project-wide basis, provide the following:
   1. Total cement used, in pounds
   2. Total cement substitutes used, in pounds

PART 2 -- PRODUCTS

2.1 MATERIALS

A. CDF for Pipe Bedding and Initial Backfill:
   1. Mix proportioning:
      a. Aggregate, cement, pozzolan, and water: Proportioned by weight or by volume.

b. Cementitious materials: Consisting of Portland cement and pozzolan.
c. Combined content of cement and pozzolan: Between 300 and 400 pounds per cubic yard with water totaling between 400 and 500 pounds per cubic yard of material produced. Within these limits, the amounts of cement and pozzolan may be varied to produce a fluid workable mix.
d. Minimum 7-day compressive strength: Between 75 psi and 200 psi.
e. Maximum 28-day compressive strength: No greater than 300 psi.
f. Water content: Sufficient to produce the fluid workable mix but not exceeding that required to maintain the fine aggregate in suspension and prevent segregation.

2. Aggregate:
   a. Aggregate grading requirements: Per approved submittal or as agreed to by the Project Representative.
   b. Acceptable Materials:
      1) ASTM C 33 specification aggregates within specified gradations, or
      2) Pea gravel with sand, or
      3) ¾" minus aggregate with sand, or
      4) Native sandy soils, with more than 10% passing a No. 200 sieve, or
      5) Quarry waste products, generally 3/8" minus aggregate.
3. Air entraining agents:
   a. May be added to improve the workability of the mix, provided the air content of the concrete slurry mix does not exceed 15 percent by volume.
   b. Conform to ASTM C260.
4. Pozzolan: ASTM C618, Class F.
5. Cement:
   a. ASTM C150, Type I or II Portland Cement
   b. ASTM C595, Type IL-Portland-Limestone Cement (Blend Hydraulic Cement).
6. Water: clean and potable.

PART 3 --EXECUTION

3.1 INSTALLATION

A. Prior to placing as pipe bedding, place the pipe to proper alignment and grade and support by blocking underneath the pipe to provide the minimum bedding depth shown on the Drawings.

B. Place CDF bedding in such a manner and rate that the pipes being installed do not become buoyant or otherwise disturbed.

C. Weather conditions:
   1. May be placed as pipe bedding if weather conditions are favorable.
   2. At the time of placement, CDF must have a temperature of at least 40 degrees F.
   3. Stop mixing and placement when the temperature is 38 degrees F or less and falling.
   4. Make each stage of placement of fill as continuous an operation as practicable.
   5. Do not place CDF on frozen ground.

D. Remove groundwater in trench prior to placement of CDF.

E. Contain trench sections to be filled at either end of trench section by bulkhead or earth fill.

F. Place in the trench bottom in multiple/two lifts. Place the first lift uniformly on both sides of the pipe and allow to set prior to placing the second lift and subsequent lifts. The depth of the subsequent lifts shall be limited as necessary to prevent pipe buoyancy.

G. Vibrate the fill by hand-operated mechanical compactor to remove voids underneath the pipe.

H. Prior to the start of construction, demonstrate the workability, setting characteristics, and strength of the resultant mix through the preparation of a trial or test section of the pipeline.

I. The test section shall simulate, as nearly as possible, the field installation conditions in a typical lower trench area of the work. Modifications may require an additional test section for approval, as determined by the Project Representative.

3.2 MIXING

A. Thoroughly mix the concrete slurry in a rotary drum or other approved type mixer.

B. Continue mixing until the cement and water are thoroughly dispersed throughout the material.

C. Place concrete slurry within 1 hour after mixing.

3.3 PLACEMENT

A. Ensure the integrity of the completed pipeline system, conforming to the requirements of the trench bedding, and backfill details shown on the Drawings.

B. Limit lift heights to avoid floating the pipe or other structures.

END OF SECTION

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SECTION 03 31 00 - CAST-IN-PLACE CONCRETE

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Provide cast-in-place concrete, as indicated in accordance with the Contract Documents.

B. The following types of concrete are covered in this Section:

1. Structural Concrete

a. Regular Mix: Floor slabs, columns, walls, pavements, and other concrete items not indicated otherwise in the Contract Documents.

2. Other Concretes

a. Sitework Concrete: Concrete to be used for curbs, gutters, catch basins, sidewalks, fence and guard post embedment, underground duct bank encasement, and other concrete appurtenant to electrical facilities, unless otherwise indicated.

b. Lean Concrete

1) Concrete to be used for thrust blocks, pipe trench cut-off blocks, and cradles that are indicated as unreinforced

2) Lean concrete shall be used as protective cover for dowels intended for future connections.

C. The term "hydraulic structure" shall mean concrete structures for the containment or transmission of water.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Mix Designs

1. Prior to beginning the WORK and within 14 Days of the Notice to Proceed, submit preliminary concrete mix designs which shall show the proportions and gradations of materials proposed for each class and type of concrete.

2. Mix designs shall be checked through trial batch and laboratory testing by an independent testing laboratory acceptable to the ENGINEER.

3. Costs related to trial batch and related laboratory testing shall be CONTRACTOR’s responsibility as part of the WORK.

4. Since laboratory trial batches require 35 calendar days to complete, the CONTRACTOR shall test a minimum of 2 mix designs for each class of concrete.

C. Delivery Tickets

1. Where ready-mix concrete is used, the CONTRACTOR shall furnish delivery tickets at the time of delivery of each load of concrete.

2. Each ticket shall show the state-certified equipment used for measuring and the total quantities, by weight, of cement, sand, each class of aggregate, admixtures, the amount of water in the aggregate added at the batching plant, and the amount allowed to be added at the Site for the specific design mix.

3. In addition, each ticket shall state the mix number, total yield in cubic yards, and the time of day, to the nearest minute, corresponding to the times when the batch was dispatched, when it left the plant, when it arrived at the Site, when unloading began, and when unloading was finished.

D. Test Data: Test data relating to the cement, aggregate, and admixtures shall be less than 6 months old.

E. Furnish the following submittals in accordance with ACI 301 – Structural Concrete:

1. mill tests for cement

2. admixture certification, including chloride ion content

3. aggregate gradation test results and certification

4. materials and methods for curing

1.3 CONCRETE CONFERENCE

A. The ENGINEER or OWNER will chair a meeting to review the detailed requirements of the CONTRACTOR's proposed concrete design mixes and to determine the procedures for producing proper concrete construction no later than 14 Days after the Notice to Proceed.

B. Parties involved in the concrete WORK shall attend the conference, including the following at a minimum:

1. CONTRACTOR's representative

2. testing laboratory representative

3. concrete subcontractor

4. reinforcing steel subcontractor and detailer

5. concrete supplier

6. admixture manufacturer's representative

C. The conference shall be held at a time and place proposed by the CONTRACTOR and accepted by the ENGINEER.

1.4 QUALITY ASSURANCE

A. General

1. Tests on component materials and for compressive strength and shrinkage of concrete shall be performed as indicated.

2. Tests for determining slump shall be in accordance with ASTM C 143 – Test Method for Slump of Hydraulic Cement Concrete.

3. Testing for aggregate shall include sand equivalence, reactivity, organic impurities, abrasion resistance, and soundness, according to ASTM C 33 – Concrete Aggregates.

4. The cost of trial batch laboratory tests on cement, aggregates, and concrete shall be the CONTRACTOR's responsibility.

5. The cost of laboratory tests on field-placed cement, aggregates, and concrete and the cost of Special Inspections required by Code will be the OWNER'S responsibility.

6. The CONTRACTOR shall be responsible for the cost of any tests and investigations of WORK that is determined to be Defective WORK.

7. The testing laboratory shall meet or exceed ASTM C 1077 – Practice for Laboratories Testing Concrete and Concrete Aggregates for use in Construction and Criteria for Laboratory Evaluation.

8. Concrete for testing shall be furnished by the CONTRACTOR, and the CONTRACTOR shall assist the ENGINEER in obtaining samples and disposal and cleanup of excess material.

B. Inspections

1. Continuous inspection by a special inspector approved by the local building department having jurisdiction and by the ENGINEER will be required where necessary to conform with Code requirements.

2. Costs of the special inspector shall be paid by the OWNER.

3. Inspection reports shall be submitted to the ENGINEER.

4. The special inspector shall observe the following for conformance to the Contract Documents:

   a. the preparation and taking of required test specimens; and,

   b. placement of concrete, except sitework concrete fully supported on earth.

C. Field Compression Tests

1. Compression test specimens shall be taken during construction from the first placement of each type of concrete and at intervals thereafter as selected by the ENGINEER to insure continued compliance with the Specifications.

2. Each set of specimens shall be a minimum of 5 cylinders.

3. Compression test specimens for concrete shall be made in accordance with Section 9.2 of ASTM C 31 – Practices for Making and Curing Concrete Test Specimens in the Field.

4. Specimens shall be 6-inches diameter by 12-inches tall cylinders.

5. Compression tests shall be performed in accordance with ASTM C 39 – Test Method for Compressive Strength of Cylindrical Concrete Specimens.

6. One test cylinder shall be tested at 7 Days, and 2 test cylinders tested at 28 Days.

7. The remaining cylinders shall be held to verify test results, if needed.

D. Evaluation and Acceptance of Concrete

1. Evaluation and acceptance of the compressive strength of concrete shall be in accordance with ACI 318 – Building Code Requirements for Reinforced Concrete, Chapter 26 “Construction Documents and Inspection”, and as indicated.

2. A statistical analysis of compression test results shall be performed according to ACI 214 – Recommended Practice for Evaluation of Strength Test Methods.

3. The standard deviation of the test results shall not exceed 640 psi, when ordered at equivalent water content as estimated by slump.

4. If any concrete fails to meet these requirements, immediate corrective action shall be taken to increase the compressive strength for subsequent batches of the type of concrete affected.

5. When the standard deviation of the test results exceeds 640 psi, the average strength for which the mix is designed shall be increased by an amount necessary to satisfy the statistical requirement that the probability of any test being more than 500 psi below or the average of any 3 consecutive tests being below the required compressive strength is 1 in 100.

6. The required average strength shall be calculated by Criterion No. 3 of ACI 214 using the actual standard deviation.

7. Concrete that fails to meet the ACI requirements and the indicated requirements is subject to removal and replacement.

E. Shrinkage Tests

1. Drying shrinkage tests shall be performed for the trial batches indicated in the Article below entitled "Trial Batch and Laboratory Tests," for the first placement of each class of structural concrete except pea gravel mix, and during placement to determine continued compliance.

2. Structural pea gravel mix does not need to be tested for shrinkage.

3. Drying shrinkage specimens shall be 4-inch by 4-inch by 11-inch prisms with an effective gauge length of 10-inches, and fabricated, cured, dried, and measured in

accordance with ASTM C 157 – Test Method for Length Change of Hardened Hydraulic Cement Mortar and Concrete, modified as follows:

a. Specimens shall be removed from molds at an age of 23 hours, plus or minus one hour, after trial batching, and shall be placed immediately in water at 70 degrees F, plus or minus 3 degrees F, for at least 30 minutes.

b. Specimens shall be measured within 30 minutes thereafter to determine original length and then shall be submerged in saturated lime water at 73 degrees F, plus or minus 3 degrees F.

c. Measurement to determine expansion expressed as a percentage of original length shall be made at age 7 Days.

d. This length at age 7 Days shall be the base length for drying shrinkage calculations ("0" days drying age).

e. Specimens then shall be stored immediately in a humidity control room maintained at 73 degrees F, plus or minus 3 degrees F, and 50 percent relative humidity, plus or minus 4 percent, for the remainder of the test.

f. Measurements to determine shrinkage, expressed as percentage of base length, shall be performed and reported separately for 7, 14, 21, and 28 Days of drying after 7 Days of moist curing.

4. The drying shrinkage deformation of each specimen shall be computed as the difference between the base length (at "0" days drying age) and the length after drying at each test age.

5. The average drying shrinkage deformation of the specimens shall be computed to the nearest 0.0001 inch at each test age.

6. If the drying shrinkage of any specimen departs from the average of that test age by more than 0.0004 inch, the results obtained from that specimen shall be disregarded.

7. Results of the shrinkage test shall be reported to the nearest 0.001 percent of shrinkage.

8. Compression test specimens shall be taken in each case from the same concrete used for preparing drying shrinkage specimens.

9. These tests shall be considered a part of the normal compression tests for the project.

10. Allowable shrinkage limitations are indicated in PART 2 - PRODUCTS, below.

F. Aggregate Testing: Aggregate testing shall be performed for the trial batch in the Article below entitled “Trial Batch and Laboratory Tests” prior to construction and every 12 months during construction to determine continued compliance.

G. Construction Tolerances

1. The CONTRACTOR shall set and maintain concrete forms and perform finishing operations to ensure that the completed WORK is within tolerances.

2. Surface defects and irregularities are defined as finishes and are different from tolerances.

3. Tolerance is the permissible variation from lines, grades, or dimensions indicated on the Drawings.

4. Where tolerances are not indicated, permissible deviations shall be in accordance with ACI 117 – Standard Tolerance for Concrete Construction and Materials.

5. The following non-cumulative construction tolerances apply to finished walls, columns and slabs unless otherwise indicated:

ITEM	TOLERANCE
Variation of the constructed linear outline from the established position in plan.	in 10 feet: 1/4 inch in 20 feet or more: 1/2 inch
Variation from the level or from the grades indicated.	in 10 feet: 1/4 inch in 20 feet or more: 1/2 inch
Variation from plumb	in 10 feet: 1/4 inch in 20 feet or more: 1/2 inch
Variation in the thickness of slabs and walls.	minus 1/4 inch plus 1/2 inch
Variation in the locations and sizes of slabs and wall openings	plus or minus 1/4 inch

PART 2 -- PRODUCTS

2.1 CONCRETE MATERIALS

A. General

1. Concrete materials in contact with potable water shall be classified as acceptable for potable water use in accordance with NSF/ANSI Standard 61 as required by the authority having jurisdiction. Not all products listed herein are for use in contact with potable water.

2. Cement for concrete that will contact potable water shall not be obtained from kilns that burn metal rich hazardous waste fuel.

3. Materials shall be delivered, stored, and handled so as to prevent damage by water or breakage.

4. Cement reclaimed from cleaning bags or leaking containers shall not be used.

5. Cement shall be used in the sequence of receipt of shipments.

B. Materials and storage of materials shall comply with ACI 301, as applicable.

C. Materials for concrete shall conform to the following requirements:

1. Cement

a. Cement shall be standard brand Portland cement conforming to ASTM C 150 – Portland Cement, for Type II or Type V, including Table 2 optional requirements.

b. A minimum of 85 percent of cement by weight shall pass a 325 screen.

c. A single brand of cement shall be used throughout the WORK, and prior to its use, the brand shall be accepted by the ENGINEER.

d. The cement shall be suitably protected from exposure to moisture until used.

e. Cement that has become lumpy shall not be used.

f. Sacked cement shall be stored in such a manner so as to permit access for inspection and sampling.

g. Certified mill test reports, including fineness, for each shipment of cement to be used shall be submitted to the ENGINEER, if requested, regarding compliance with the Specifications.

2. Water

a. Water shall conform to ASTM C1602 – Mixing Water Used in the Production of Hydraulic Cement Concrete.

b. Water for mixing and curing shall be potable, clean, and free from objectionable quantities of silty organic matter, alkali, salts, and other impurities.

c. The water shall be considered potable, for the purposes of this Section only, if it meets the requirements of the local governmental agencies.

d. Agricultural water with high total dissolved solids (greater than 1000 mg/L TDS) shall not be used.

3. Aggregates

a. Aggregates shall be obtained from pits acceptable to the ENGINEER, shall be non-reactive, and shall conform to ASTM C 33 – Concrete Aggregates.

b. The maximum size of coarse aggregate shall be as indicated, and the substitution of lightweight sand for fine aggregate will not be permitted.

c. Coarse Aggregates

1) Coarse aggregates shall consist of clean, hard, durable gravel, crushed gravel, crushed rock, or a combination thereof.

2) The coarse aggregates shall be prepared and handled in 2 or more size groups for combined aggregates, with a maximum size greater than 3/4 inch.

3) When the aggregates are proportioned for each batch of concrete, the 2 size groups shall be combined (also refer to the Article below entitled "Trial Batch and Laboratory Tests").

d. Fine Aggregates

1) Fine aggregates shall be natural sand or a combination of natural and manufactured sand that is hard and durable.

2) When tested in accordance with ASTM D 2419 – Test Methods for Sand Equivalent Value of Soils and Fine Aggregate, the sand equivalency shall not be less than 75 percent for an average of 3 samples, nor less than 70 percent for an individual test.

3) The gradation of fine aggregate shall conform to ASTM C 33 when tested in accordance with ASTM C 136 for the fineness modulus of the sand used, including the optional grading in Section 6.2.

4) The fineness modulus of sand used shall not be greater than 3.1.

5) When tested in accordance with ASTM C 33, the fine aggregate shall produce a color in the supernatant liquid no darker than the reference standard color solution.

e. Combined Aggregates

1) Combined aggregates shall be well graded from coarse to fine sizes and shall be uniformly graded between screen sizes to produce concrete that has optimum workability and consolidation characteristics.

2) Where a trial batch is required for a mix design, the final combined aggregate gradations will be established during the trial batch process.

3) When tested in accordance with ASTM C 33, the coarse aggregate shall show a loss not exceeding 42 percent after 500 revolutions or 10.5 percent after 100 revolutions.

f. When tested in accordance with ASTM C 33, the ratio of silica released to reduction in alkalinity shall not exceed 1.0.

g. When tested in accordance with ASTM C 33, the loss resulting after 5 cycles of the soundness test shall not exceed 10 percent for fine aggregate and 12 percent for coarse aggregate when using sodium sulfate.

4. Ready-mixed concrete shall conform to the requirements of ASTM C 94 – Ready Mixed Concrete.

5. Admixtures

a. Admixtures shall be compatible and shall be furnished by a single manufacturer capable of providing qualified field service representation.

b. Admixtures shall be used in accordance with manufacturer's recommendations.

c. If the use of an admixture is producing an inferior end result, the CONTRACTOR shall discontinue use of the admixture.

d. Admixtures shall not contain thiocyanates nor more than 0.05 percent chloride ion, and shall be non-toxic after 30 days.

e. Air Content

1) An air-entraining agent meeting the requirements of ASTM C 260 – Air Entraining Admixtures for Concrete shall be used.

2) Concrete floors to receive a dry-shake floor hardener shall have an air content not to exceed 3 percent. Otherwise, the air content in the concrete shall be between 4.5 to 7.5 percent.

3) The OWNER reserves the right, at any time, to sample and test the air-entraining agent.

4) The air-entraining agent shall be added to the batch in a portion of the mixing water.

5) The solution shall be batched by means of a mechanical batcher capable of accurate measurement.

6) Air content shall be tested at the point of placement.

7) The air entraining agent shall be Micro-Air by Master Builders; Daravair by W.R. Grace; Sika AEA-15 by Sika Corporation; or equal

f. Set-Controlling and Water-Reducing Admixtures

1) Admixtures may be added at the CONTRACTOR's option, subject to the ENGINEER’s approval, to control the set, effect water reduction, and increase workability.

2) The cost of adding an admixture shall be the CONTRACTOR's responsibility.

3) Concrete containing an admixture shall be first placed at a location determined by the ENGINEER.

4) Admixtures shall conform to ASTM C 494 – Chemical Admixtures for Concrete.

5) The required quantity of cement shall be used in the mix regardless of whether or not an admixture is used.

6) Concrete shall not contain more than one water-reducing admixture, unless it can be demonstrated that the proposed mix will meet the indicated drying shrinkage requirements.

7) The set-controlling admixture may be either with or without water-reducing properties.

8) Where the air temperature at the time of placement is expected to be consistently greater than 80 degrees F, a set-retarding admixture such as **Plastocrete 161MR by Sika Corporation**, **Pozzolith or Delvo** by **BASF**, **Daratard** by **W.R. Grace**, or equal shall be used.

9) Where the air temperature at the time of placement is expected to be consistently less than 40 degrees F, a non-corrosive set accelerating admixture such as **Plastocrete 161FL** by **Sika Corporation**, **MasterSet FP 20** by **BASF**, **Daraset** by **W.R. Grace**, or equal shall be used.

10) Mid-Range Water Reducers

a) General use water-reducing admixtures shall be mid-range and shall conform to ASTM C 494, Type A and F.

b) Use Daracem by **W.R. Grace, Polyheed** by **BASF**, **Sikament** by **Sika Corporation**, or equal.

c) The quantity of admixture used and the method of mixing shall be in accordance with the manufacturer's instructions and recommendations.

11) High-Range Water Reducers

a) High-range water reducers shall conform to ASTM C 494, Type F or G.

b) Use **ADVA** by **W.R. Grace**, **ViscoCrete** by **Sika Corporation**, **Glenium** by **BASF**, or equal.

c) The high-range water reducer shall be added to the concrete after all other ingredients have been mixed and initial slump has been verified.

d) No more than 14 ounces of water reducer per sack of cement shall be used.

e) The water reducer shall be considered as part of the mixing water when calculating the water/cement ratio.

f) If the high-range water reducer is added to the concrete at the Site, it may be used in conjunction with the same water reducer added at the batch plant.

g) Concrete shall have a slump of 3 inches, plus or minus 1/2 inch, prior to adding the high-range water reducing admixture at the Site.

h) The high-range water reducing admixture shall be accurately measured and pressure injected into the mixer as a single dose by an experienced technician.

i) A standby system shall be provided and tested prior to each day's operation of the primary system.

j) Concrete shall be mixed at mixing speed for a minimum of 70 mixer revolutions or 5 minutes after the addition of the high-range water reducer, unless recommended otherwise by the manufacturer.

g. Other Admixtures

1) Flyash

a) Flyash shall not be used for concrete sections in hydraulic structures.

b) For other concrete, fly ash may be substituted for not more than 15 percent, by weight, of cement in structural concrete and not more than 30 percent, by weight, for sitework concrete, and not more than 50 percent, by weight, of cement in other concrete.

c) Fly ash shall conform to ASTM C618 and shall not have loss-on-ignition greater than 3 percent.

d) The water/cement ratio shall be calculated based on cement plus fly ash.

2) Ground Blast Furnace Slag Cement

a) Slag cement shall not be used for concrete sections in hydraulic structures.

b) Slag cement shall conform to ASTM C989 – Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars, Grade 100 or 120.

c) Blended cements shall conform to ASTM C595 – Blended Hydraulic Cements, Type 1S, or ASTM C1157 – Performance Specification for Hydraulic Cement.

d) Slag cement substitution, if used, shall be not less than 25, nor more than 50 percent by weight of cement.

e) Slag cement substitution shall not be used with fly ash substitution.

f) The water/cement ratio shall be calculated based on cement plus slag cement.

2.2 CURING MATERIALS

A. General: Curing compounds shall be resin-based and shall be compliant with local VOC requirements, unless otherwise indicated herein.

B. Regular Curing Compound

1. Regular curing compound shall be white-pigmented and shall conform to ASTM C 309 - Liquid Membrane-Forming Compounds for Curing Concrete, Type 2, Class B.

2. Sodium silicate compounds will not be accepted.

3. The concrete curing compound shall be:

    a. Kurez VOX White Pigmented by Euclid Chemicals Company;

    b. L&M Cure R-2 by L&M Construction Chemicals;

    c. 1200-White by W.R. Meadows;

    d. Kure-N-Seal WB White Pigmented by Sonneborn/Degussa Building Systems;

    e. or equal.

C. Dissipating Curing Compound

1. When the curing compound must be removed for finishes or grouting, compounds shall be of a dissipating type, conforming to ASTM C 309, Type 1 or 2, Class B.

2. The dissipating curing compound shall be:

    a. Korez DR VOX by Euclid Chemical Company;

    b. L&M Cure R-2 by L & M Construction Chemicals;

    c. 1100-Clear by W.R. Meadows;

    d. or equal.

D. Curing Compound for Applications Requiring NSF/ANSI Standard 61 Compliance

1. When the curing compound is required to conform to NSF/ANSI Standard 61, the curing compound shall be water-based and shall be compliant with all local VOC requirements; shall conform to ASTM C 309; and shall be certified to conform to the requirements of NSF/ANSI Standard 61.

2. The NSF/ANSI Standard 61 Certified curing compound shall be:

    a. E-Cure by SpecChem, LLC;

    b. Atlas Quantum-Cure NSF by Atlas Tech Products;

    c. or equal.

E. Concrete Curing Blanket

1. Polyethylene Sheets

    a. Polyethylene sheets for use as concrete curing blanket shall be white and shall have a nominal thickness of 6 mils.

b. The loss of moisture when determined in accordance with ASTM C 156 – Test Method for Water Retention by Concrete Curing Materials, shall not exceed 0.055 grams per square centimeter of surface.

2. Polyethylene-Coated Waterproof Paper

a. Polyethylene-coated waterproof paper sheeting for use as concrete curing blanket shall consist of white polyethylene sheeting free of visible defects, uniform in appearance, shall have a nominal thickness of 2-mils, and shall be permanently bonded to waterproof paper conforming to the requirements of Federal Specification UU-B-790A – Building Paper, Vegetable Fiber (Kraft, Waterproofed, Water Repellant and Fire Resistant).

b. The loss of moisture, when determined in accordance with ASTM C 156, shall not exceed 0.055 gram per square centimeter of surface.

3. Polyethylene-Coated Burlap

a. Polyethylene-coated burlap for use as concrete curing blanket shall be 4 mils thick, with white opaque polyethylene film impregnated or extruded into one side of the burlap.

b. The burlap shall weigh not less than 9 ounces per square yard.

c. The loss of moisture, when determined in accordance with ASTM C 156, shall not exceed 0.055 grams per square centimeter of surface.

F. Curing Mats

1. Curing mats for use in Curing Method 6, below, shall be heavy shag rugs or carpets or cotton mats quilted at 4 inches on center.

2. Curing mats shall weigh a minimum of 12 ounces per square yard when dry.

G. Evaporation Retardant

1. An evaporation retardant shall be used.

2. The evaporation retardant shall be:

a. MasterKure ER 50 by BASF/Master Builders;

b. Eucobar by Euclid Chemical Company;

c. E-CON by L & M Construction Chemicals, Inc.;

d. or equal.

2.3 NON-WATERSTOP JOINT MATERIALS

A. Materials for non-waterstop joints in concrete shall conform to the following requirements:

1. The preformed joint filler shall be a non-extruding neoprene sponge or polyurethane type conforming to Section 03 32 00 – Joints in Concrete.

2. The elastomeric joint sealer shall conform to Section 07 92 13 – Sealants and Caulking.

3. Mastic Joint Sealer

   a. The mastic joint sealer shall be a material:

      1) that does not contain evaporating solvents;

      2) that will tenaciously adhere to concrete surfaces;

      3) that will remain permanently resilient and pliable;

      4) that will not be affected by the continuous presence of water;

      5) that will not in any way contaminate potable water;

      6) and that will effectively seal the joints against moisture infiltration even when the joints are subject to movement from expansion and contraction.

   b. The sealer shall be composed of special asphalts or similar materials blended with lubricating and plasticizing agents to form a tough, durable mastic substance containing no volatile oils or lubricants.

   c. The sealer shall be capable of meeting the indicated test requirements, if testing is required by the ENGINEER.

2.4 MISCELLANEOUS MATERIALS

A. Bonding Agents

1. Bonding agents shall be epoxy adhesives.

2. Bonding agents for bonding freshly-mixed, plastic concrete to hardened concrete shall be:

   a. Sikadur 32 Hi-Mod Epoxy Adhesive by Sika Corporation;

   b. MasterEmaco ADH 326 by BASF/Master Builders;

   c. BurkEpoxy MV by Edoco;

   d. or equal.

3. Bonding agents for bonding hardened concrete or masonry to steel shall be:

   a. Sikadur 31 Hi-Mod Gel by Sika Corporation;

   b. BurkEpoxy NS by Edoco;

   c. Concresive Paste (LPL) by MBT/Degussa Building Systems;

   d. or equal.

B. Vapor Retarder

1. The vapor retarder shall be a plastic sheet meeting the Class A permeance and strength requirementsof ASTM E 1745 – Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs. The minimum thickness shall be 10 mils.

2. The vapor retarder shall be **Griffolyn Type-65 G** by **Reef Industries, Inc.**, or equal.

2.5 CONCRETE DESIGN REQUIREMENTS

A. General

1. Concrete shall be composed of cement, admixtures, aggregates, and water of the qualities indicated.

2. The exact proportions in which these materials are to be used for different parts of the WORK shall be determined during the trial batches.

3. In general, the mix shall be designed to produce a concrete capable of being deposited to obtain maximum density and minimum shrinkage, and, where deposited in forms, to have good consolidation properties and maximum smoothness of surface.

4. The aggregate gradations shall be formulated to provide fresh concrete that will not promote rock pockets around reinforcing steel or embedded items.

5. The proportions shall be changed whenever necessary or desirable to meet the required results, and such changes shall be subject to review by the ENGINEER.

B. Fine Aggregate Composition

1. In mix designs for structural concrete, except for 1/2-inch and 3/8-inch maximum size aggregate, the percentage of fine aggregate in total aggregate by weight shall be as indicated in the following table:

FINE AGGREGATE	
Fineness Modulus	Percent (maximum)
2.7 or less	41
2.7 to 2.8	42
2.8 to 2.9	43
2.9 to 3.1	44

2. For other concrete, the maximum percentage of fine aggregate of total aggregate by weight shall not exceed 50 percent.

C. Duct Bank Concrete

1. Duct bank concrete shall contain an integral red-oxide coloring pigment.

2. The concrete shall be dyed red throughout.

3. Using a surface treatment to color duct banks will not be accepted.

D. Water/Cement Ratio

1. The indicated water/cement ratio is for a saturated-surface dry condition of aggregate.

2. Throughout every Day, the added batch water shall be adjusted for the total free water in the aggregates, which shall be determined as follows:

   a. The total moisture content of all aggregate shall be calculated by ASTM C 566 – Test Method for Total Moisture Content of Aggregate by Drying.

   b. Subtract the moisture absorbed by the coarse aggregate, calculated by ASTM C 127 – Standard Test Method for Density, Relative Density (Specific Gravity) and Absorption of Coarse Aggregate.

   c. Subtract the moisture absorbed by the fine aggregate, calculated by ASTM C 128 – Standard Test Method for Density, Relative Density (Specific Gravity) and Absorption of Fine Aggregate.

E. Concrete Property Tables

1. The maximum cement contents (determined from the maximum W/C Ratios and maximum Water Contents given in the Concrete Property Tables below) are intended to minimize drying shrinkage and heat of hydration of the concrete.

2. It is understood that the indicated maximum cement contents may require additional water reducing agent for the workability required by the CONTRACTOR'S methods, and may not result in the least costly concrete mix for the required concrete strength.

3. If the CONTRACTOR wishes to increase the maximum cement content for any mix, the CONTRACTOR must notify the ENGINEER in writing and submit the request within 30 days of the Notice to Proceed.

4. Increases in cement content shall be at the CONTRACTOR'S expense.

STRUCTURAL CONCRETE			
Type of WORK	Regular Mix (Floor slabs, walls, pavements, and other concrete items not categorized elsewhere)	Sitework Concrete (curbs, gutters, sidewalks, catch basins, fence embedments, encasements, and ductbanks)	Lean Concrete (thrust blocks, pipe trench cut-off blocks, and cradles)
Min 28 Day Compressive Strength, psi	4,500	3,000	2,000

Max Aggregate Size, in	1	1	1
Cement Content per cubic yard, lb, minimum	564	470	376
Water content per cubic yard, lb, maximum	254	254	270
Max W/C Ratio by weight	0.42	0.45 frost or sulfates	0.60
Total Air Content, percent	4.5 to 7.5	4.5 to 7.5	3 to 6
Slump	4 inches +/- 1 in With high-range water reducer: 7 inches +/- 2 in	4 inches +/- 1 in Ductbanks and encasements: 5 inches +/- 1 in	4 inches +/- 1 in

NOTE: The CONTRACTOR is cautioned that the limiting parameters above are not a mix design. Admixtures may be required to achieve workability required by the CONTRACTOR's construction methods and aggregates. The CONTRACTOR shall be responsible for providing concrete with the required workability and strength.

F. Adjustments to Mix Design

1. The CONTRACTOR may elect to decrease the water/cement ratio to achieve the strength and shrinkage requirements and/or add water reducers, as required to achieve workability.

2. The mixes shall be changed whenever such change is necessary or desirable to secure the required strength, density, workability, and surface finish, and the CONTRACTOR shall be entitled to no additional compensation because of such changes.

3. Any changes to the accepted concrete mix design shall be submitted to the ENGINEER for review and shall be tested again in accordance with the indicated requirements.

2.6 CONSISTENCY

A. The quantity of water in a batch of concrete shall be just sufficient, with a normal mixing period, to produce a concrete that can be worked properly into place without segregation and which can be compacted by vibratory methods to give the desired density, impermeability, and smoothness of surface.

B. The quantity of water shall be changed as necessary, with variations in the nature or moisture content of the aggregates, in order to maintain uniform production of a desired consistency.

C. The consistency of the concrete in successive batches shall be determined by slump tests in accordance with ASTM C 143 – Test Method for Slump of Hydraulic Cement Concrete.

D. The slumps shall be as indicated with the concrete properties.

2.7 TRIAL BATCH AND LABORATORY TESTS

A. The CONTRACTOR shall only use a mix design for construction that has first met the trial batch testing requirements.

B. Before placing any concrete, a testing laboratory selected by the ENGINEER shall prepare a trial batch of each class of structural concrete, based on the preliminary concrete mixes submitted by the CONTRACTOR.

C. Aggregate Proportions

1. During the trial batch the aggregate proportions may be adjusted by the testing laboratory using the two coarse aggregate size ranges to obtain the required properties.

2. If one size range produces an acceptable mix, a second size range need not be used.

3. Such adjustments will be considered refinements to the mix design and will not be the basis for extra compensation to the CONTRACTOR.

4. Concrete shall conform to the indicated requirements whether the aggregate proportions are from the CONTRACTOR's preliminary mix design or whether the proportions have been adjusted during the trial batch process.

5. The trial batch shall be prepared using the aggregates, cement, and admixture proposed for the project.

D. The trial batch materials shall be of a quantity such that the testing laboratory can obtain 3 drying shrinkage and 6 compression test specimens from each batch.

E. The determination of compressive strength shall be made by testing 6-inch diameter by 12-inch high cylinders, which have been made, cured, and tested in accordance with ASTM C 192 – Practice for Making and Curing Concrete Test Specimens in the Laboratory, and ASTM C 39.

F. The testing schedule shall be 3 compression test cylinders tested at 7 Days and 3 at 28 Days.

G. The average compressive strength for the 3 cylinders tested at 28 Days for any given trial batch shall be not less than 125 percent of the indicated compressive strength.

H. A sieve analysis of the combined aggregate for each trial batch shall be performed according to the requirements of ASTM C 136 – Method for Sieve Analysis of Fine and Coarse Aggregates, and values shall be provided for percent passing each sieve.

2.8 SHRINKAGE LIMITATION

A. General

1. The CONTRACTOR shall only use a mix design for construction that has first met the trial batch shrinkage requirements.

2. Shrinkage limitations shall apply only to structural concrete.

B. Maximum Shrinkage

1. The maximum concrete shrinkage for specimens cast in the laboratory from the trial batch, as measured at 21-Day drying age or at 28-Day drying age, shall be 0.036 percent or 0.042 percent, respectively.

2. Standard deviation will not be considered.

3. The maximum concrete shrinkage for specimens cast in the field shall not exceed the trial batch maximum shrinkage requirement by more than 25 percent.

C. If the required shrinkage limitation is not met during construction, the CONTRACTOR shall take any or all of the following actions to reestablish compliance:

1. changing the source of aggregates, cement and/or admixtures;

2. reducing water/cement ratio;

3. washing of coarse and/or fine aggregate to reduce fines;

4. increasing the number of construction joints;

5. modifying the curing requirements; or

6. other actions to minimize shrinkage or the effects of shrinkage.

2.9 MEASUREMENT OF CEMENT AND AGGREGATE

A. The amount of cement and of each separate size of aggregate entering into each batch of concrete shall be determined by direct weighing equipment furnished by the CONTRACTOR and acceptable to the ENGINEER.

B. Weighing Tolerances

Material	Percent of Total Weight
Cement	1
Aggregates	3
Admixtures	3

2.10 MEASUREMENT OF WATER

A. The quantity of water entering the mixer shall be measured by a suitable water meter or other measuring device of a type acceptable to the ENGINEER and capable of measuring the water in variable amounts within a tolerance of one percent.

B. The water feed control mechanism shall be capable of being locked in position in order to constantly deliver the required amount of water to each batch of concrete.

C. A positive, quick-acting valve shall be used for a cut-off in the water line to the mixer, and the operating mechanism shall prevent leakage when the valve is closed.

2.11 READY-MIXED CONCRETE

A. General

1. Ready-mixed concrete that meets the indicated requirements as to materials, batching, mixing, transporting and placement shall be used. It shall be in accordance with ASTM C 94 and the following supplementary requirements.

2. Ready-mixed concrete shall be delivered to the WORK, and discharge shall be completed within 90 minutes after the addition of the cement to the aggregates or before the drum has been revolved 250 revolutions, whichever occurs first.

3. The use of non-agitating equipment for transporting ready-mixed concrete will not be permitted.

4. Combination truck and trailer equipment for transporting ready-mixed concrete will not be permitted.

5. The quality and quantity of materials used in ready-mixed concrete and in batch aggregates shall be subject to continuous inspection at the batching plant by the ENGINEER.

B. Counters

1. Truck mixers shall be equipped with electrically-actuated counters by which the number of revolutions of the drum or blades may be readily verified.

2. The counter shall be of the resettable, recording type and shall be mounted in the driver's cab.

3. The counters shall be actuated at the time of starting the mixers at mixing speeds.

C. Mixing

1. Each batch of concrete shall be mixed in a truck mixer for not less than 70 revolutions of the drum or blades at the rate of rotation designated by the manufacturer of equipment.

2. Additional mixing, if any, shall be at the speed designated by the manufacturer of the equipment as agitating speed.

3. Materials, including the mixing water, shall be in the mixer drum before actuating the revolution counter for determining the number of revolutions of mixing.

D. Uniformity

1. Truck mixers and their operation shall be such that the concrete throughout the mixed batch as discharged is within acceptable limits of uniformity with respect to consistency, mix, and grading.

2. If slump tests taken at approximately the 1/4- and 3/4-point of the load during discharge result in slumps differing by more than one inch when the required slump is 3 inches or less, or if they differ by more than 2 inches when the required slump is more than 3 inches, the mixer shall not be used on the WORK unless the causative condition is corrected and satisfactory performance is verified by additional slump tests.

3. Mechanical details of the mixer, such as water measuring and discharge apparatus, condition of the blades, speed of rotation, general mechanical condition of the unit, and clearance of the drum, shall be checked before a further attempt to use the unit will be permitted.

E. Each batch of ready-mixed concrete delivered to the Site shall be accompanied by a delivery ticket that is furnished to the ENGINEER in accordance with the Paragraph in Part 1 of this Section entitled "Delivery Tickets."

PART 3 -- EXECUTION

3.1 PROPORTIONING AND MIXING

A. Proportioning of the mix shall conform to ACI 301.

B. Mixing shall conform to ACI 301.

C. Slumps shall be as indicated.

D. Re-tempering of concrete or mortar that has partially hardened will not be permitted.

3.2 PREPARATION OF SURFACES FOR CONCRETING

A. General

1. Earth surfaces shall be thoroughly wetted by sprinkling prior to the placing of any concrete, and these surfaces shall be kept moist by frequent sprinkling up to the time of placing concrete thereon.

2. The surface shall be free from standing water, mud, and debris at the time of placing concrete.

B. Joints in Concrete

1. Construction joints are defined as concrete surfaces upon which or against which concrete is to be placed, but placement of concrete has been stopped or interrupted and the ENGINEER has determined that the new concrete cannot be incorporated integrally with the concrete previously placed.

2. The surfaces of horizontal joints shall be given a compacted, roughened surface for good bonding.

3. Except where coated joint surfaces have been indicated, the joint surfaces shall be cleaned of laitance, loose or defective concrete, foreign material, and be roughened to a minimum 1/4-inch amplitude.

4. Cleaning and roughening shall be accomplished by hydroblasting or sandblasting (exposing aggregate) followed by thorough washing.

5. Pools of water shall be removed from the surface of construction joints before the new concrete is placed.

6. Gravel

   a. After the surfaces have been prepared, each approximately horizontal construction joint shall be covered with a 6-inch lift of a pea gravel mix.

   b. The gravel mix shall be placed and spread uniformly.

   c. Wall concrete shall follow immediately and shall be placed upon the fresh pea gravel mix.

C. Placement Interruptions

1. When placing of concrete is to be interrupted long enough for the concrete to take a set, the working face shall be given a shape by the use of forms or other means that will secure proper union with subsequent WORK.

2. Such construction joints shall be made only where acceptable to the ENGINEER.

D. Embedded Items

1. No concrete shall be placed until the formwork, the installation of parts to be embedded, the reinforcement steel, and the preparation of surfaces involved in the placing have been completed and accepted by the ENGINEER at least 4 hours before the placement of concrete.

2. Surfaces of forms and embedded items that have become encrusted with dried grout from previous usage shall be cleaned before the surrounding or adjacent concrete is placed.

3. Inserts or other embedded items shall conform to the indicated requirements.

4. Reinforcement, anchor bolts, sleeves, inserts, and similar items shall be set and secured in the forms at locations as indicated or shown by Shop Drawings, and shall be acceptable to the ENGINEER before any concrete is placed.

5. Accuracy of placement shall be the responsibility of the CONTRACTOR.

E. Casting New Concrete Against Old Concrete

1. Where concrete is to be cast against old concrete (defined as any concrete which is greater than 60 Days old), the surface of the old concrete shall be thoroughly cleaned and roughened by hydroblasting or sandblasting to expose aggregate.

2. The joint surface shall be coated with an epoxy bonding agent unless determined otherwise by the ENGINEER.

F. Water

1. No concrete shall be placed in any structure until water entering the space to be filled with concrete has been properly cut off or has been diverted by pipes or other means, and carried out of the forms, clear of the WORK.

2. No concrete shall be deposited underwater nor shall the CONTRACTOR allow still water to rise on any concrete until the concrete has attained its initial set.

3. Water shall not be permitted to flow over the surface of any concrete in such manner and at such velocity as will injure the surface finish of the concrete.

4. Pumping or other necessary dewatering operations for removing ground water, if required, shall be subject to review by the ENGINEER.

G. Corrosion Protection

1. Pipe, conduit, dowels, and other ferrous items required to be embedded in concrete construction shall be positioned and supported prior to placement of concrete such that there will be a minimum of 2 inches clearance between said items and any part of the concrete reinforcement.

2. Securing such items in position by wiring or welding them to the reinforcement will not be permitted.

H. Openings for pipes, inserts for pipe hangers and brackets, and anchors shall be provided, where practicable, during the placement of concrete.

I. Anchor bolts shall be accurately set and shall be maintained in position by templates while embedded in the concrete.

J. Cleaning: The surfaces of metalwork to be in contact with the concrete shall be thoroughly cleaned of dirt, grease, loose scale and rust, grout, mortar, and other foreign substances immediately before the concrete is placed.

3.3 HANDLING, TRANSPORTING, AND PLACING

A. General

1. The placement of concrete shall conform to the applicable portions of ACI 301 and the indicated requirements.

2. No aluminum materials shall be used in conveying any concrete.

B. Non-Conforming WORK or Materials

1. Concrete which during or before placing is found not to conform to the indicated requirements will be rejected and shall be immediately removed from the WORK.

2. Concrete that is not placed in accordance with these requirements or which is of inferior quality shall be removed and replaced.

C. Unauthorized Placement

1. No concrete shall be placed except in the presence of an authorized representative of the ENGINEER.

2. The CONTRACTOR shall notify the ENGINEER in writing at least 24 hours in advance of the placement of any concrete.

D. Placement in Wall and Column Forms

1. Concrete shall not be dropped through reinforcement steel or into any deep form, nor shall concrete be placed in any form in such a manner as to leave accumulation of mortar on the form surfaces above the placed concrete.

2. In such cases, means such as hoppers and, if necessary, vertical ducts of canvas, rubber, or metal shall be used for placing concrete in the forms in a manner that it may reach the place of final deposit without separation.

3. In no case shall the free fall of concrete below the ends of ducts, chutes, or buggies exceed 4 feet in walls and 8 feet in columns.

4. Concrete shall be uniformly distributed during the process of deposition, and in no case after deposition shall any portion be displaced in the forms more than 6 feet in the horizontal direction.

5. Concrete in wall forms shall be deposited in uniform horizontal layers not deeper than 2 feet, and care shall be exercised to avoid inclined layers or inclined construction joints except where such are required for sloping members.

6. Each layer shall be placed while the previous layer is still soft.

7. The rate of placing concrete in wall forms shall not exceed 5 feet of vertical rise per hour.

8. Sufficient illumination shall be provided in the interior of forms such that the concrete at the places of deposit is visible from the deck or runway.

E. Casting New Concrete Against Old

1. An epoxy adhesive bonding agent shall be applied to the old surfaces according to the manufacturer's written recommendations.

2. This provision shall not apply to joints where waterstop has been provided.

3. Refer to Section 03 32 00 – Joints in Concrete, for other requirements.

F. Conveyor Belts and Chutes

1. Ends of chutes, hopper gates, and other points of concrete discharge throughout the CONTRACTOR's conveying, hoisting, and placement system shall be designed and arranged such that concrete passing from them will not fall separated into whatever receptacle immediately receives it.

2. Conveyor belts, if used, shall be of a type acceptable to the ENGINEER.

3. Chutes longer than 50 feet will not be permitted.

4. The minimum slopes of chutes shall be such that concrete of the indicated consistency will readily flow in them.

5. If a conveyor belt is used, it shall be wiped clean by a device operated in such a manner that none of the mortar adhering to the belt will be wasted.

6. Conveyor belts and chutes shall be covered.

G. Placement in Slabs

1. Concrete placement in sloping slabs shall proceed uniformly from the bottom of the slab to the top for the full width of the placement.

2. As the WORK progresses, the concrete shall be vibrated and carefully worked around the slab reinforcement, and the surface of the slab shall be screeded in an up-slope direction.

H. Temperature of Concrete

1. The temperature of concrete when it is being placed shall be not more than 90 degrees F nor less than 50 degrees F.

2. For sections less than 12 inches thick, the temperature of concrete when placed shall be not less than 55 degrees F.

I. Hot or Cold Weather Procedures

1. If required by the ENGINEER, the CONTRACTOR shall submit detailed procedures for the production, transportation, placement, protection, curing, and temperature monitoring of concrete during hot or cold weather.

2. The submittal shall include procedures to be implemented upon abrupt changes in weather conditions or equipment failures.

3. The CONTRACTOR shall not be entitled to additional compensation for satisfying the hot weather placement or the cold weather placement requirements below.

J. Hot Weather Placement

1. If the temperature of the concrete is 85 degrees F or greater, the time between introducing the cement into the aggregates and discharge shall not exceed 45 minutes.

2. If the concrete is placed when the weather is such that the temperature of the concrete would exceed 90 degrees F, the CONTRACTOR shall employ effective means such as pre-cooling of aggregates, using ice as mixing water, or placing at night as necessary to maintain the temperature of the concrete below 90 degrees F as it is placed.

3. During the curing period, the maximum temperature decrease measured at the surface of the concrete shall not exceed 50 degrees F in 24 hours nor 5 degrees F in one hour.

K. Cold Weather Placement

1. The placement of concrete shall conform to ACI 306.1 – Cold Weather Concreting, and the following requirements:

   a. Remove snow, ice, and frost from the surfaces, including reinforcement, against which concrete is to be placed.

   b. Before beginning concrete placement, thaw the subgrade to a minimum depth of 6 inches.

   c. Reinforcement and embedded items shall be warmed to above 32 degrees F prior to concrete placement.

   d. Maintain the concrete temperature above 50 degrees F for at least 72 hours after placement.

   e. Concrete ingredients shall not be heated more than necessary to prevent the temperature of the mixed concrete, as placed, from falling below the minimum temperature criterion.

3.4 PUMPING OF CONCRETE

A. General: If the pumped concrete does not produce satisfactory end results, the CONTRACTOR shall discontinue the pumping operation and proceed with the placing of concrete using conventional methods.

B. Pumping Equipment

1. The pumping equipment shall have 2 cylinders and shall be designed to operate with one cylinder in case the other one is not functioning.

2. In lieu of this requirement, the CONTRACTOR may have a standby pump on the Site during pumping.

3. The minimum diameter of the hose conduits shall be in accordance with ACI 304.2R – Placing Concrete by Pumping Methods.

4. Pumping equipment and hose conduits that are not functioning properly shall be replaced.

5. Aluminum conduits for conveying the concrete will not be permitted.

C. Field Control: Concrete samples for slump, air content, and test cylinders shall be taken at the placement end of the hose.

3.5 ORDER OF PLACING CONCRETE

A. General

1. The order of placing concrete in the WORK shall be acceptable to the ENGINEER.

2. In order to minimize the effects of shrinkage, the concrete shall be placed in units as bounded by construction joints at the indicated locations.

B. 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 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.

C. Concrete Surfaces

1. The surface of the concrete shall be level whenever a run of concrete is stopped.

2. For a level, straight, intermediate joint on the exposed surface of walls, a wood strip at least 3/4-inch thick shall be tacked to the forms on these surfaces.

3. The concrete shall be carried approximately 1/2 inch above the underside of the strip.

4. The strip shall be removed one hour after the concrete is placed, and any irregularities in the edge formed by the strip shall be leveled with a trowel and laitance shall be removed.

3.6 TAMPING AND VIBRATING

A. As concrete is placed in the forms or in excavations, it shall be thoroughly settled and compacted throughout the entire depth of the layer which is being consolidated, into a dense and homogeneous mass, filling all corners and angles, thoroughly embedding the reinforcement, eliminating rock pockets, and bringing only a slight excess of water to the exposed surface of concrete.

B. Vibrators

1. Vibrators shall be Group 3 in accordance with ACI 309 – Consolidation of Concrete, high speed power vibrators (8000 to 12,000 rpm) of an immersion type in sufficient number and with at least one standby unit as required.

2. Group 2 vibrators may be used only at specific locations when accepted by the ENGINEER.

C. Waterstops

1. Care shall be exercised when placing concrete around waterstops.

2. The concrete shall be carefully worked by rodding and vibrating to make sure that air and rock pockets have been eliminated.

3. Where flat-strip type waterstops have been placed horizontally, the concrete shall be worked under the waterstops by hand, making sure that air and rock pockets have been eliminated.

4. Concrete that is surrounding the waterstops shall be given additional vibration over and above that used for adjacent concrete placement to ensure complete embedment of the waterstops in the concrete.

D. Concrete in Walls

1. Concrete in walls shall be internally vibrated and at the same time rammed, stirred, or worked with suitable appliances, tamping bars, shovels, or forked tools until it completely fills the forms or excavations and closes snugly against each surface.

2. Subsequent layers of concrete shall not be placed until the layers previously placed have been worked thoroughly.

3. Vibrators shall be provided in sufficient numbers, with standby units as required, to accomplish the required results within 15 minutes after concrete of the prescribed consistency has been placed in the forms.

4. The vibrating head shall not contact the surfaces of the forms.

5. Care shall be exercised not to vibrate concrete excessively or to work it in any manner that causes segregation of its constituents.

3.7 FINISHING CONCRETE SURFACES

A. General

1. Concrete surfaces shall be free from fins, bulges, ridges, offsets, honeycombing, or roughness of any kind, and shall present a finished, smooth, continuous hard surface.

2. Allowable deviations from plumb or level and from the alignment, profiles, and dimensions are defined as tolerances and shall be as indicated.

3. These tolerances are to be distinguished from irregularities in finish as indicated.

4. Aluminum finishing tools shall not be used.

B. Formed Surfaces

1. No treatment shall be required after form removal except for curing, repair of defective concrete, and treatment of surface defects.

2. Where architectural finish is required, treatment(s) shall be as indicated.

3. Surface holes larger than 1/2 inch in diameter or deeper than 1/4 inch are defined as surface defects in basins and exposed walls.

C. Unformed Surfaces

1. General

   a. After proper and adequate vibration and tamping, unformed top surfaces of slabs, floors, walls, and curbs shall be brought to a uniform surface with suitable tools.

   b. Immediately after the concrete has been screeded it shall be treated with a liquid evaporation retardant, and the retardant shall be used again after each operation as necessary to prevent drying shrinkage cracks.

2. The classes of finish for unformed concrete surfaces are defined as follows:

a. Finish U1

1) Sufficient leveling and screeding to produce an even, uniform surface with surface irregularities not to exceed 3/8 inch.

2) No further special finish is required.

b. Finish U2

1) After sufficient stiffening of the screeded concrete, surfaces shall be float finished with wood or metal floats or with a finishing machine using float blades.

2) Excessive floating of surfaces while the concrete is plastic and dusting of dry cement and sand on the concrete surface to absorb excess moisture will not be permitted.

3) Floating shall be the minimum necessary to produce a surface that is free from screed marks and is uniform in texture.

4) Surface irregularities shall not exceed 1/4 inch.

5) Joints and edges shall be tooled where indicated or as determined by the ENGINEER.

c. Finish U3

1) After the Finish U2 surface has hardened sufficiently to prevent excess of fine material from being drawn to the surface, steel troweling shall be performed with firm pressure such as will flatten the sandy texture of the floated surface and produce a dense, uniform surface free from blemishes, ripples, and trowel marks.

2) The finish shall be smooth and free of irregularities.

d. Finish U4

1) Trowel the Finish U3 surface to remove local depressions or high points.

2) In addition, the surface shall be given a light broom finish with brooming perpendicular to drainage unless otherwise indicated.

3) The resulting surface shall be sufficiently rough to provide a nonskid finish.

e. Unformed surfaces shall be finished according to the following schedule:

UNFORMED SURFACE FINISH SCHEDULE	
Area	Finish
grade slabs and foundations to be covered with concrete or fill material	U1

floors to be covered with grouted tile or topping grout	U2
water bearing slabs with slopes 10 percent and less	U3
water bearing slabs with slopes greater than 10 percent	U4
slabs not water bearing	U4
slabs to be covered with built-up roofing	U2
interior slabs and floors to receive architectural finish	U3
top surface of walls	U3

3.8 ARCHITECTURAL FINISHES

A. General

1. Architectural finishes shall be provided only where specifically indicated below.

2. In other locations, the Paragraph entitled "Finishing Concrete Surfaces" shall apply.

Location	Finish
All exposed formed and unformed surfaces above grade, including the insides of all areas that hold fish.	Smooth Concrete Finish

B. Immediately after the forms have been stripped, the concrete surface shall be inspected and any poor joints, voids, rock pockets, or other defective areas shall be repaired and form-tie holes filled as indicated.

C. Architectural finishes shall not be applied until the concrete surface has been repaired as required and the concrete has cured at least 14 Days.

D. Architecturally treated concrete surfaces shall conform to the accepted example in texture, color, and quality, and it shall be the CONTRACTOR's responsibility to maintain and protect the concrete finish.

E. Smooth Concrete Finish

1. The concrete surface shall be wetted, and a grout shall be applied with a brush.

2. The grout shall be made by mixing one part Portland cement and one part of fine sand that will pass a No. 16 sieve, with sufficient water to give it the consistency of thick paint.

3. Cement used in the grout shall be 1/2 gray and 1/2 white Portland cement, or other proportion as determined by the ENGINEER.

4. White Portland cement shall be **Atlas White**, or equal.

5. Calcium chloride at 5 percent by volume of the cement shall be used in the brush coat.

6. Application

   a. The freshly applied grout shall be vigorously rubbed into the concrete surface with a wood float filling the small air holes.

   b. After the surface grout has been removed with a steel trowel, the surface shall be allowed to dry and, when dry, shall be vigorously rubbed with burlap to remove completely the remaining surface grout such that there is no visible paint-like film of grout on the concrete.

   c. The entire cleaning operation for any area shall be completed the same day it is started, and no grout shall be left on the surface overnight.

7. Operations

   a. Cleaning operations for any given day shall be terminated at panel joints.

   b. The various operations shall be carefully timed to secure the desired effect which is a light-colored concrete surface of uniform color and texture without any appearance of a paint or grout film.

8. In the event that improper manipulation results in an inferior finish, the CONTRACTOR shall rub such inferior areas with carborundum bricks.

9. Before beginning any of the final treatment on exposed surfaces, the CONTRACTOR shall treat in a satisfactory manner a trial area of at least 200 square feet in some inconspicuous place selected by the ENGINEER and shall preserve said trial area undisturbed until final completion.

3.9 CURING AND DAMPPROOFING

A. General: Concrete shall be cured for not less than 7 Days after placement, in accordance with the methods indicated below for the different parts of the WORK.

Surface to be Cured or Dampproofed	Method
unstripped forms	1
construction joints between footings and walls, and between floor slab and columns	2
encasement and ductbank concrete and thrust blocks	3
concrete surfaces not specifically indicated in this Paragraph	4
floor slabs on grade in hydraulic structures	5
slabs not on grade	6
wall sections with forms removed	6

B. Method 1

1. Wooden forms shall be wetted immediately after concrete has been placed and shall be kept wet with water until removal.

2. If steel forms are used the exposed concrete surfaces shall be kept continuously wet until the forms are removed.

3. If forms are removed within 7 Days of placing the concrete, curing shall be continued in accordance with Method 6, below.

C. Method 2

1. The surface shall be covered with burlap mats which shall be kept wet with water for the duration of the curing period, until the concrete in the walls has been placed.

2. No curing compound shall be applied to surfaces cured under Method 2.

D. Method 3

1. The surface shall be covered with moist earth not less than 4 hours nor more than 24 hours after the concrete is placed.

2. Earthwork operations that may damage the concrete shall not begin until at least 7 Days after placement of the concrete.

E. Method 4

1. The surface shall be sprayed with a liquid curing compound.

2. The compound shall be applied in accordance with the manufacturer's printed instructions at a maximum coverage rate of 200 square feet per gallon and in such a manner as to cover the surface with a uniform film that will seal thoroughly.

3. Seal Protection

   a. Where the curing compound method is used, care shall be exercised to avoid damage to the seal during the 7-Day curing period.

   b. If the seal is damaged or broken before expiration of the curing period, the break shall be repaired immediately by the application of additional curing compound over the damaged portion.

4. Wherever curing compound has been applied by mistake to surfaces against which concrete subsequently is to be placed and to which it is to adhere, such compound shall be entirely removed by wet sandblasting just prior to the placing of new concrete.

5. Application Schedule

   a. The curing compound shall be applied as soon as the concrete has hardened enough to prevent marring on unformed surfaces and within 2 hours after removal of forms.

b. Repairs to formed surfaces shall be made within the 2 hour period; provided, however, that any such repairs which cannot be made within the said 2 hour period shall be delayed until after the curing compound has been applied.

c. When repairs are to be made to an area on which curing compound has been applied, the area involved shall first be wet-sandblasted to remove the curing compound.

6. At locations where concrete is placed adjacent to a panel which has been coated with curing compound, the panel shall have curing compound reapplied to an area within 6 feet of the joint and to any other location where the curing membrane has been disturbed.

7. Prior to final acceptance of the WORK, visible traces of curing compound shall be removed in such a manner that does not damage the surface finish.

F. Method 5

1. Until the concrete surface is covered with curing compound, the entire surface shall be kept damp by applying water using nozzles that atomize the flow such that the surface is not marred or washed.

2. The concrete shall be given a coat of curing compound in accordance with Method 4, above.

3. Not less than one hour nor more than 4 hours after the curing compound has been applied, the surface shall be wetted with water delivered through a fog nozzle, and concrete-curing blankets shall be placed on the slabs.

4. Curing Blankets

a. The curing blankets shall be laid with the edges butted together and with the joints between strips sealed with 2-inch wide strips of sealing tape or with edges lapped not less than 3 inches, and fastened together with a waterproof cement to form a continuous watertight joint.

b. The curing blankets shall be left in place during the 7-Day curing period and shall not be removed until after concrete for adjacent WORK has been placed.

c. If the curing blankets become torn or otherwise ineffective, the CONTRACTOR shall replace damaged sections.

d. During the first 3 Days of the curing period, no traffic of any nature and no depositing, temporary or otherwise, of any materials will be permitted on the curing blankets.

e. During the remainder of the curing period, foot traffic and temporary depositing of materials that impose light pressure will be permitted only on top of plywood sheets 5/8-inch minimum thickness, laid over the curing blanket.

f. The CONTRACTOR shall add water under the curing blanket as often as necessary to maintain damp concrete surfaces.

G. Method 6

1. Method 6 shall apply to both walls and slabs.

2. The concrete shall be kept continuously wet by the application of water for a minimum period of at least 7 Days, beginning immediately after the concrete has reached final set or the forms have been removed.

3. Until the concrete surface is covered with the curing mats, the entire surface shall be kept damp by applying water using nozzles that atomize the flow such that the surface is not marred or washed.

4. Curing Mats

   a. Heavy curing mats shall be used as a curing medium to retain the moisture during the curing period.

   b. The curing mats shall be weighted or otherwise held substantially in contact with the concrete surface to prevent dislodging by wind or other causes.

   c. Edges shall be continuously held in place.

5. The curing mats and concrete shall be kept continuously wet by the use of sprinklers or other means both during and after normal working hours.

6. Immediately after the application of water has terminated at the end of the curing period, the curing mats shall be removed, the entire concrete surface shall be wetted, and curing compound shall be immediately applied to the entire surface in accordance with Method 4, above.

7. The CONTRACTOR shall dispose of excess water from the curing operation in order to avoid damage to the WORK.

3.10 PROTECTION

A. The CONTRACTOR shall protect the concrete against damage until final acceptance.

B. Weather Protection

1. Fresh concrete shall be protected from damage due to rain, hail, sleet or snow.

2. The CONTRACTOR shall provide such protection while the concrete is still plastic and whenever precipitation is imminent or occurring.

3.11 CURING DURING COLD WEATHER

A. Water curing of concrete may be reduced to 6 Days during periods when the mean daily temperature in the vicinity of the Site is less than 40 degrees F, provided that during the prescribed period of water curing, when temperatures are such that concrete surfaces may freeze, water curing has been temporarily discontinued.

B. Compound-Cured Concrete

1. Concrete that is to be cured by an application of curing compound shall require no additional protection from freezing if the protection at 50 degrees F for 72 hours is

obtained by means of approved insulation in contact with the forms or concrete surfaces.

2. Otherwise, the concrete shall be protected against freezing temperatures for 72 hours immediately following 72 hours protection at 50 degrees F.

C. Concrete cured by water shall be protected against freezing temperatures for 72 hours immediately following the 72 hours of protection at 50 degrees F.

D. Discontinuance of Protection

1. Discontinuance of protection against freezing temperatures shall be such that the drop in temperature of any portion of the concrete will be gradual and will not exceed 40 degrees F in 24 hours.

2. In the spring, when the mean daily temperature rises above 40 degrees F for more than 3 successive Days, the required 72-hour protection at a temperature not lower than 50 degrees F may be discontinued for as long as the mean daily temperature remains above 40 degrees F, provided that the concrete shall be protected against freezing temperatures for not less than 48 hours after placement.

E. Artificial Heat

1. Where artificial heat is employed, special care shall be taken to prevent the concrete from drying.

2. The use of unvented heaters will be permitted only when unformed surfaces of concrete adjacent to the heaters are protected for the first 24 hours from an excessive carbon dioxide atmosphere by application of curing compound, provided that the use of curing compound for such surfaces is otherwise permitted.

3.12 TREATMENT OF SURFACE DEFECTS

A. General

1. Surface defects are defined in Finishing Concrete Surfaces, above.

2. As soon as forms are removed, the exposed concrete surfaces shall be carefully examined and any irregularities shall be immediately rubbed or ground in order to secure a smooth, uniform, and continuous surface satisfactory to the ENGINEER.

3. Plastering or coating of surfaces to be smoothed will not be permitted.

4. No repairs shall be made until after inspection by the ENGINEER.

5. In no case will extensive patching of honeycombed concrete be permitted.

6. Concrete containing minor voids, holes, honeycombing, or similar depression defects shall be repaired as indicated below.

7. Concrete containing extensive voids, holes, honeycombing, or similar depression defects shall be completely removed and replaced..

8. Repairs of surface defects shall be performed promptly.

B. Preparation

1. Defective surfaces to be repaired shall be cut back from trueline a minimum depth of 1/2-inch over the entire area.

2. Feathered edges will not be permitted.

3. Where chipping or cutting tools are not required in order to deepen the area properly, the surface shall be prepared for bonding by the removal of laitance and soft material, plus not less than 1/32-inch depth of the surface film from hard portions by means of an efficient sandblast.

4. After cutting and sandblasting, the surface shall be wetted sufficiently in advance of shooting with shotcrete or with cement mortar such that while the repair material is being applied the surfaces underneath will remain moist but not so wet as to overcome the suction upon which a good bond depends.

C. Materials

1. The material used for repair shall consist of a mixture of one sack of cement to 3 cubic feet of sand.

2. For exposed walls, the cement shall contain such a proportion of Atlas White Portland cement as is required to make the color of the patch match the color of the surrounding concrete.

D. Holes

1. Holes left by tie-rod cones shall be reamed with suitably toothed reamers in order to leave the surfaces of the holes clean and rough.

2. Holes then shall be repaired in an approved manner with dry-packed cement grout.

3. Holes left by form-tying devices having a rectangular cross section and other imperfections having a depth greater than their least surface dimension shall not be reamed but shall be repaired in an approved manner with dry-packed cement grout.

E. Repairs

1. Repairs shall be built up and shaped in such a manner that the completed WORK will conform to the indicated requirements, using approved methods which will not disturb the bond, cause sagging, or cause horizontal fractures.

2. The surfaces of repaired concrete shall receive the same kind and amount of curing treatment as required for the concrete in the repaired section.

F. Cracks: Prior to filling any structure with water, cracks shall be repaired to the satisfaction of the ENGINEER.

3.13 CARE AND REPAIR OF CONCRETE

A. The CONTRACTOR shall protect concrete against injury or damage from excessive heat, lack of moisture, overstress, or any other cause until Final Acceptance.

B. Particular care shall be exercised in order to prevent the drying shrinkage damage of concrete and to avoid roughening or otherwise damaging the concrete surface.

C. Any concrete found to be damaged, or which may have been originally defective, or which becomes defective at any time prior to the final acceptance of the completed WORK, or which departs from the established line or grade, or which, for any other reason, does not conform to the requirements of the Contract Documents, shall be repaired or removed and replaced with acceptable materials to the satisfaction of the ENGINEER.

END OF SECTION

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SECTION 03 31 10 – STRUCTURAL CONCRETE REHABILITATION

PART 1 -- PART 1 - GENERAL

1.1 THE SUMMARY

A. This Specification Section covers supply, remedial work, and placement of epoxy injection grout necessary to repair cracks in the lower dam spillway. Epoxy grout injection under this section shall not begin until video inspection of the fish release pipe has been conducted, the spillway screens have been removed, moss and debris has been removed from the spillway, and excavation for the tailrace and fish ladder modifications to full depth has been made.

B. This Specification Section covers supply, remedial work and placement of epoxy grout injection, repair mortar and crack filler necessary to repair cracks in the spillway crest.

1.2 RECORD DOCUMENTS

A. Reference Drawings and other provisions of the Contract Documents including, but not limited to General Conditions and Special Conditions apply to all sections.

1.3 APPLICABLE CODES AND STANDARDS

A. The latest edition of the following codes and standards shall apply to the Work of this Section:

American Concrete Institute (ACI)

ACI 503R	Use of Epoxy Compounds with Concrete

ASTM International (ASTM)

ASTM C881	Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete

1.4 SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals.

B. Action Submittals

1. Manufacturer's data for epoxy grout detailing physical and chemical properties for epoxy adhesives.

2. Technical data for metering, mixing, and injection equipment.

3. Detailed work and safety plans for crack repairs and injection grouting.

C. Informational Submittals

1. Injection grout applicator/worker qualifications.

a. Manufacturer’s Site representative.

b. Injection applicator.

c. Injection pump operating technician.

2. Manufacturer’s recommended surface preparation procedures and application instructions for epoxy adhesives.

3. Injection crew and job foreman shall provide written and verifiable evidence showing compliance with required applicator qualifications.

4. Manufacturer’s Certificate of Compliance: Certified test results for each batch of epoxy adhesive.

1.5 HANDLING, STORAGE AND PREPARATION

A. Store premixed grout in the manufacturer's sealed containers, with seals and label intact, in a weatherproof, damp-proof enclosure with a raised floor.

B. Store adhesive containers at ambient temperatures below 110 degrees F and above 45 degrees F.

C. Package adhesive material in new sealed containers and label with following information:

1. Manufacturer’s name.

2. Product name and lot number.

3. ANSI Hazard Classification.

4. ANSI recommended precautions for handling.

5. Mix ratio by volume.

1.6 APPLICATOR QUALIFICATIONS

A. The company injecting and applying grout shall have at least five (5) years of recent, continuous experience in similar work and shall be a certified applicator of the material and equipment manufacturer.

1. The restoration firm shall have completed at least ten (10) similar projects in the last five (5) years.

2. Injection grouting workers shall have satisfactorily completed a program of instruction/certification in the methods of restoring concrete structures. The curriculum shall include the theory in the nature and causes of concrete cracking, methods for permanently repairing damaged concrete structures, the technical aspects of correct material selection and the use, operation, maintenance and troubleshooting of injection equipment. The injection grouting workers shall have successfully completed at least ten (10) similar projects.

PART 2 -- PRODUCTS

2.1 The injection resin shall be a two-component structural epoxy grout which has the capability to bond to concrete and steel surfaces.

A. Specified Products: Unless otherwise recommended by the grout manufacturer based on site conditions and crack widths and accepted by the Owner, the following injection products shall be used:

1. For injection of cracks up to 1/4 inch the two-component epoxy grout shall have a mixed viscosity from 300 to 600 centipoise (cps) at 73°F. For use below 60°F and for fine cracks (10 mil or less), the grout shall have a mixed viscosity at 73°F of 150 to 225 cps. Grout shall have a heat deflection temperature of at least 130°F. All other physical properties shall comply with the provisions of ASTM C881, Type IV.

2. For the repair of cracks/gaps larger than 1/4 inch a two-component epoxy grout with low viscosity and long potlife (1.5 hours minimum) shall be used. The product shall have physical properties which meet the provisions of ASTM C881, Type I with the exception that a cure time of 14 days is allowed for all tests.

B. Injection grout surface seal material shall be a non-sagging, rapid curing, epoxy gel, and shall have sufficient strength to resist injection pressures adequately to prevent leakage during injection and cure. The sealing material shall have adequate strength to hold injection ports in place.

2.2 REPAIR MORTAR

A. Provide repair mortar as a pre-packaged, 2-component, polymer-modified, cementitious, non-sag mortar, specifically formulated for the repair of surface defects.

B. Repair mortar shall have the following properties:

Physical Property	**Value**	**ASTM Standard**
Compressive Strength (min.)		C-109
at 7 days	4000 psi	
at 28 days	6000 psi	
Bond Strength (min.)		C-882 (modified)
at 28 days	2000 psi	
Freeze/Thaw resistance (min.)		C-666
300 cycles	98 percent	

1. Provide a minimum repair thickness of 1/2 inch, unless otherwise indicated.

2.3 SURFACE SEAL

A. Sufficient strength and adhesion for holding injection fittings firmly in place, and to resist pressures preventing leakage during injection.

B. Capable of removal after injection adhesive has cured.

2.4 MIXING

A. Proportion: Mix grout in the proportions and according to the procedures recommended by the manufacturer.

B. Mixing Equipment:

1. General: Mix grout in an approved mechanical mixer.

2. Injection Grout Equipment: Mixer/injector equipment shall have a positive displacement type pump (electric or air powered) to provide positive ratio control of exact proportions of the two components at the nozzle. The pumps shall provide in-line metering and mixing with automatic pressure control, capable of discharging the mixed grout at any pre-set pressure up to 150 psi (+ 5 psi) with a manual pressure control override. The equipment shall be capable of maintaining the grout volume ratio prescribed by the manufacturer within a tolerance of + 5 % by volume at any discharge pressure from 0 psi to 150 psi. The equipment shall be equipped with sensors on both the component A and component B reservoirs that will automatically, immediately stop the machine when either reservoir becomes dry. At the start of each workday, a pressure test of the two component lines and mixing head shall be performed to check for proper performance in accordance with equipment manufacturer's procedures. These tests shall be run on each machine after every four hours of use.

2.5 MAP CRACK REPAIR

A. Provide crack filler as a high viscosity, rapid setting, thixotropic, epoxy resin, formulated for filling cracks on vertical surfaces.

B. Crack filler shall have the following properties:

Physical Property	**Value**	**ASTM Standard**
Compressive Strength (min.)		C-881
at 7 days	10,000 psi	
Bond Strength (min.)		C-881
at 2 days	1000 psi	

1. Crack filler shall be Rezi-Weld Gel Paste, by WR Meadows, or Approved equal.

2.6 SOURCE QUALITY CONTROL

A. Pot Life Test

1. Perform tests for each batch of adhesive.

2. Condition Components A and B to required temperature.

3. Measure components in ratio of Component B as stated on manufacturer's label into an 8-fluid ounce paper cup.

4. Start stopwatch immediately and mix components for 60 seconds using wooden tongue depressor, take care to scrape sides and bottom of cup periodically.

5. Probe mixture once with tongue depressor every 30 seconds, starting 2 minutes prior to minimum specified pot life.

6. Pot Life Definition: Time at which a soft stringy mass forms in center of cup

PART 3 -- EXECUTION

3.1 Spalled concrete repair:

A. General:

1. If encountered, repair spalled concrete at the crack in the spillway using repair mortar.

B. Surface Preparation:

1. Remove all unsound concrete beyond the spalled area.

3.2 Boundaries:

A. Determine the boundaries of the patch by sawcuts to a depth of one inch deep.

B. Avoid excessive or complex edge conditions.

3.3 Sawcuts:

A. Perform sawcuts undercut at 5 degrees from perpendicular.

B. Construct sawcuts in maximum 1/2-inch increments.

C. Chip away concrete within the repair area to a depth sufficient to expose sound concrete over the entire repair area, or to a minimum depth required by repair mortar, whichever is greater.

D. Base the selection of partial depth concrete removal equipment on the size of repair area, depth of concrete to be removed, and the location of the deteriorated concrete.

3.4 Removal:

A. The maximum allowable pneumatic chipping hammer shall be a 15-lb class hammer.

B. Sand blasting or pressure washing (4000 psi minimum) shall be utilized for final cleaning of the prepared spall area prior to repair mortar installation.

C. Remove any water blasting debris daily in order to prevent it from setting up.

D. If a chipping hammer is used, ensure that the existing reinforcement is not damaged during the concrete removal operations.

E. Remove protrusions, such as mortar spatter or fins, by grinding or by striking with a hammer or other tool.

3.5 Repair Mortar:

A. Apply repair mortar in accordance with the manufacturer's recommendations.

B. The thickness of each lift of repair mortar shall be in accordance with the manufacturer's recommendations, with the minimum thickness being not less than 1/2 inch.

C. Fully consolidate the repair mortar, working the material into the substrate to completely fill all pores and voids in the area to be filled.

D. Bring the repair surface into alignment with the adjacent existing surfaces in order to provide a uniform, even surface.

E. Match the repair surface to adjacent existing surfaces in texture by applying necessary coatings and surface treatments.

F. Float-finish the repaired surface using wood or sponge floats.

G. Minimum and maximum ambient and surface temperatures shall be as recommended by repair material manufacturer.

3.6 Curing:

A. Provide curing in accordance with the manufacturer's recommendations except that the minimum cure period shall be 7 days.

B. During cold weather, maintain the repair material temperature above 50 degrees F for at least 3 days after placement.

3.7 Crack Injection:

A. Following curing of repair mortar at crack, epoxy grout the crack in accordance with this specification. Repair mortar will serve as crack sealing surface.

3.8 Injection Epoxy Grouting:

A. General:

1. Pressure injection epoxy grouting for the cracks in the spillway or other repair areas as may be directed by the Owner, shall be in accordance with the grout manufacturer's requirements. Specific grouting procedures shall be submitted to the Owner for review. Choose repair materials to match the adjacent concrete surface in color.

B. Preparation

1. Surfaces in and adjacent to cracks shall be cleaned and thoroughly flushed of sediments and other foreign matter detrimental to bond of epoxy injection seal.

2. Entry ports shall be drilled at alternating sides of the crack at spacing equaling the depth of crack in that location. If depth of crack is undeterminable, ports should be spaced at a minimum of 12 inches on center. If recommended by the grout manufacturer for the specific crack being grouted, the ports may be installed through the sealing material; in such case the surface seal material shall be applied to the face of the crack between the entry ports.

3. Enough time for the surface seal material to gain adequate strength shall pass before proceeding with grout injection.

C. Epoxy Grout Injection

1. For vertical cracks, injection grouting shall begin at lowest entry port and continue until there is an appearance of grout at the next port adjacent to the entry port being pumped.

2. For horizontal cracks, start at one end of the crack and work to the other end, filling the crack until the pressure can be maintained.

3. For very fine cracks, start the injection of repair material at the widest end and proceed toward the thinner end, using low-viscosity repair material.

4. When grout travel is indicated by appearance at the next port, injection shall be discontinued on the entry port being pumped, and grout injection shall be transferred to the next adjacent port where grout has appeared.

5. Grout injection shall be performed continuously until the crack being injected is completely filled.

6. If port to port travel of grout is not indicated, the work shall be immediately stopped, and the Owner shall be notified immediately. The situation shall be remedied by installing additional ports or other means as may be appropriate.

D. Finishing

1. When cracks are completely filled, grout shall be cured for sufficient time to allow removal of surface seal without any draining or run-back of grout from the cracks.

2. Surface seal material and ports shall be ground flush with the existing surface.

3.9 Map Crack repair:

A. Follow Manufacturer's written instructions for surface preparation, mixing, and filling of cracks in vertical surfaces.

3.10 Inspection:

A. Give the OWNER 72 hours of notice of intention to prepare work areas and place grout.

END OF SECTION

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SECTION 03 32 00 - JOINTS IN CONCRETE

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide joints in concrete, complete and in place, in accordance with the Contract Documents.

B. Joints in concrete structures shall be the types defined below and will be permitted only where indicated, unless specifically accepted by the ENGINEER.

1.2 TYPES OF JOINTS

A. Construction Joints

1. When fresh concrete is placed against a hardened concrete surface, the joint between the pours shall be defined as a construction joint.

2. Unless otherwise indicated, joints in water-bearing members shall be provided with a waterstop and/or sealant groove of the shape indicated.

B. Contraction Joints

1. Contraction joints are similar to construction joints except that the fresh concrete shall not bond to the hardened surface of the earlier pour.

2. The slab reinforcement shall be stopped 4-1/2 inches from the joint; which is provided with a sleeve-type dowel, in order to allow shrinkage of the concrete of the later pour.

3. Waterstop and/or sealant groove shall be provided where indicated.

C. Expansion Joints

1. In order to allow the concrete to expand freely, a space shall be provided between the 2 pours, and the joint shall be formed as indicated.

2. The space shall be obtained by placing a filler joint material against the earlier pour to act as a form for the later pour.

3. Unless otherwise indicated, expansion joints in water bearing members shall be provided with a center-bulb type waterstop.

4. Provide premolded expansion joint material with the edge at the indicated distance below or back from the finished concrete surface.

5. Provide a slightly tapered, dressed, and oiled wooden strip secured to or placed at the edge of the expansion joint during concrete placement and remove the strip later to form a space for the sealing material.

6. The space so formed shall be filled with a joint sealant material as indicated below. In order to keep the 2 wall or slab elements in line, the joint shall also be provided with a sleeve-type dowel as indicated.

D. Control Joints

1. The function of the control joint is to provide a weaker plane in the concrete where shrinkage cracks would likely occur.

2. Formed Groove

a. A groove, of the shape and dimensions indicated, shall be formed or saw-cut in the concrete and the groove shall then be filled with a joint sealant material.

b. The formed groove shall be placed in the first of the two sections cast at the control joint, in order to assure that the sealant bonds to the second section across the joint and not to the cement paste from the first pour.

1.3 CONTRACTOR SUBMITTALS

A. Shop Drawings

1. Furnish placement drawings showing the location and types of joints for each structure.

2. Test Reports

a. Furnish certified test reports from the sealant manufacturer on the actual batch of material supplied, demonstrating compliance with the indicated requirements.

b. Furnish the test reports before using the sealant on the Project.

3. Welding Certification

a. Furnish copies of the waterstop welding certification by manufacturer or authorized agent of the manufacturer.

b. Every person who is to be involved with waterstop installation shall be required to have individual certification on file with the ENGINEER, stating that the named individual is certified and trained to install waterstop in accordance with the manufacturer's recommendations and specifications.

4. Furnish manufacturer's information demonstrating compliance of the following with the indicated requirements:

a. bearing pad

b. neoprene sponge

c. preformed joint filler

d. backing rod

e. waterstop

f. slip dowels

g. PVC tubing

B. Samples

1. Prior to production of the material required under this Section, submit qualification samples of waterstops which accurately represent the material being provided.

2. Such samples shall be extruded or molded sections of each size or shape to be installed.

3. The balance of the material to be used shall not be produced until after the ENGINEER has reviewed the qualification samples.

C. Certificates

1. Furnish written certification from the manufacturer, as an integral part of the shipping form, that the material shipped to the Site meets or exceeds the indicated physical property requirements.

2. Supplier certificates will not be accepted.

1.4 QUALITY ASSURANCE

A. Waterstop Inspection

1. Waterstop field joints shall be subject to inspection, and no such WORK shall be scheduled or started without having made prior arrangements with the ENGINEER for the required inspections.

2. Provide not less than 24 hours notice for the scheduling of such inspections.

3. Field joints in waterstops shall be subject to inspection for misalignment, bubbles, inadequate bond, porosity, cracks, offsets, and other defects that would reduce the potential resistance of the material to water pressure at any point.

4. Defective field joints shall be replaced with material that passes inspection, and faulty material shall be removed from the Site and destroyed.

B. The following waterstop defects represent a partial list of defects which shall be grounds for rejection:

1. offsets at joints greater than 1/16 inch or 15 percent of material thickness at any point, whichever is less

2. exterior cracking at the joint due to incomplete bond, which is deeper than 1/16 inch or 15 percent of material thickness at any point, whichever is less.

3. any combination of offset or exterior cracking that will result in a net reduction in the cross-section of the waterstop in excess of 1/16 inch or 15 percent of material thickness at any point, whichever is less.

4. misalignment of the joint which results in misalignment of the waterstop in excess of 1/2 inch in 10 feet

5. porosity in the welded joint as evidenced by visual inspection.

6. bubbles or inadequate bonding which can be detected with a penknife test. (If, while prodding the entire joint with the point of a penknife, the knife breaks through the outer portion of the weld into a bubble, the joint shall be considered defective.)

7. visible signs of separation when the cooled splice is bent by hand at any sharp angle

8. evidence of burned material

C. Waterstop Samples

1. Prior to use of the waterstop material in the field, a sample of a prefabricated (shop made fitting) mitered cross and a tee constructed of each size or shape of material to be used shall be submitted.

2. Samples shall be prefabricated (shop made fitting) so that the material and workmanship represent the fittings to be provided.

3. In addition, field samples of prefabricated fittings (crosses, tees, and the like) will be selected at random by the ENGINEER for testing by a laboratory at the OWNER's expense.

4. When tested, the tensile strength across the joints shall be at least 1120 psi for PVC waterstops.

D. Construction Joint Sealant

1. The CONTRACTOR shall prepare adhesion and cohesion test specimens at intervals of 5 Days while sealants are being installed.

2. The sealant material shall show no signs of adhesive or cohesive failure when tested in accordance with the following procedure in laboratory and field tests:

   a. Sealant specimen shall be prepared between 2 concrete blocks (1-inch by 2-inch by 3-inch).

   b. Spacing between the blocks shall be one inch.

   c. Coated spacers (2-inch by 1-1/2-inch by 1/2-inch) shall be used to set and hold sealant cross-sections of 1/2-inch by 2-inch with a width of one inch.

   d. The sealant shall be cast and cured in accordance with the manufacturer's recommendations, except that the curing period shall be not less than 24 hours.

e. Following the curing period, the gap between the blocks shall be widened to 1-1/2 inches, and spacers shall be used to maintain this gap for 24 hours prior to inspection for failure.

1.5 SPECIAL CORRECTION OF DEFECTS REQUIREMENT

A. The CONTRACTOR shall furnish a 5-year written warranty of the entire sealant installation against faulty and/or incompatible materials and workmanship, together with a statement that the CONTRACTOR agrees to repair or replace, to the satisfaction of the OWNER, any defective areas which become evident within the 5-year period.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Joint materials shall be listed as compliant with NSF Standard 61.

2.2 WATERSTOPS

A. PVC Waterstops

1. Waterstops shall be extruded from an elastomeric polyvinyl chloride compound containing the plasticizers, resins, stabilizers, and other materials necessary to meet the indicated requirements of this Section.

2. No reclaimed or scrap material shall be used.

3. The CONTRACTOR shall obtain from the waterstop manufacturer and shall furnish to the ENGINEER for review, current test reports and a written certification of the manufacturer that the material to be shipped to the Site meets the physical requirements as outlined in the U.S. Army Corps of Engineers Specification CRD-C572-PVC Waterstops, and those indicated.

4. Flatstrip and Center-Bulb Waterstops

a. Flatstrip and center-bulb waterstops shall be manufactured such that at no place shall the thickness of waterstops, including the center bulb type, be less than 3/8 inch.

b. The waterstop shall be provided with hog rings installed at 12 inches on centers along the waterstop.

c. Shapes shall be as indicated, or as acceptable to the ENGINEER.

5. Multi-Rib Waterstops

a. Multi-rib waterstops shall be as indicated or as acceptable to the ENGINEER.

b. Prefabricated joint fittings shall be used at intersections of the ribbed-type waterstops.

6. Retrofit Waterstops

a. Retrofit waterstops and batten bars shall be as indicated or as acceptable to the ENGINEER.

b. The waterstop shall be supplied as a complete system including waterstop, SS batten bar, SS anchor bolts, and epoxy gel.

7. When tested in accordance with the indicated test standards, the waterstop material shall meet or exceed the following requirements:

Physical Property, Sheet Material	Value	ASTM Std
Tensile Strength-min, psi	2,000	D 638, Type IV
Ultimate Elongation-min, percent	350	D 638, Type IV
Low Temp Brittleness, max degrees F	-35	D 746
Stiffness in Flexure, min, psi	600	D 747
Accelerated Extraction (CRD-C572		
Tensile Strength-min, psi	1,500	D 638, Type IV
Ultimate Elongation, min, percent	300	D 638, Type IV
Effect of Alkalis (CRD-C572		
Change in Weight, percent	plus 0.25/minus 0.10	------
Change in Durometer, Shore A	plus and minus 5	D 2240
Finish Waterstop		
Tensile Strength-min, psi	1,400	D 638, Type IV
Ultimate Elongation, min percent	280	D 638, Type IV

B. Preformed Hydrophilic Waterstop

1. Hydrophilic (bentonite-free) waterstops shall be **Hydro-Flex Waterstop** as manufactured by **Henry Co.**, or **Earthshield Type 23**, as manufactured by **JP Specialties**, or equal.

2. The cross-sectional area of the waterstop shall not be less than 0.5 square inch.

3. Hydrophilic waterstop shall be the type that expands in the presence of water to form a watertight joint seal without damaging the concrete in which it is cast.

4. The waterstop shall be manufactured from butyl rubber with hydrophilic properties.

5. The waterstop shall have a delay coating to inhibit initial expansion due to moisture present in fresh concrete.

6. The minimum expansion ratio of modified chloroprene shall be not less than 2-to-1 volumetric change in distilled water at 70 degrees F (21 degrees C).

7. The bonding agent for hydrophilic waterstop shall be the manufacturer's recommended adhesive for wet, rough concrete.

C. When types of waterstops not listed above are indicated, they shall be subjected to the same requirements as those listed in this Section.

2.3 JOINT SEALANT FOR WATER-BEARING JOINTS

A. The joint sealant shall be a polyurethane polymer designed for bonding to concrete which is continuously submerged in water.

B. No material will be accepted which has an unsatisfactory history as to bond or durability when used in the joints of water-retaining structures.

C. Joint sealant material shall meet the following requirements (73 degrees F and 5 percent R.H.):

Work Life, minutes	45 - 180
Time to Reach 20 Shore A Hardness (at 77 degrees F, 200-gram quantity), max	24 hours
Ultimate Hardness (ASTM D 2240, Shore A)	20 - 45
Tensile Strength (ASTM D 412), min	175 psi
Ultimate Elongation (ASTM D 412), minimum	400 percent
Tear Resistance (Die C, ASTM D 624), pounds per inch of thickness, min	75
Color	Light Gray

D. Polyurethane sealants for waterstop joints in concrete shall conform to the following requirements:

1. Sealant shall be 2-part polyurethane with the physical properties of the cured sealant conforming to or exceeding the requirements of ASTM C 920 – Elastomeric Joint Sealant, or Federal Specification TT-S-0227 E(3) - Sealing Compound, Elastomeric Type, Multicomponent, for Caulking, Sealing, and Glazing Buildings and Other Structures, for 2-part material, as applicable.

2. For vertical joints and overhead horizontal joints, only "non-sag" compounds shall be used, conforming to the requirements of ASTM C 920, Class 25, Grade NS, or Federal Specification TT-S-0227 E(3), Type II, Class A.

3. For plane horizontal joints, use the self-leveling compounds meeting the requirements of ASTM C 920 Class 25, Grade P, or Federal Specification TT-S-0227 E(3), Type I.

4. For joints subject to either pedestrian or vehicular traffic, a compound providing non-tracking characteristics and having a Shore A hardness range of 35 to 45 shall be used.

5. Primer materials, if recommended by the sealant manufacturer, shall conform to the printed recommendations of the manufacturer.

E. Sealant Manufacturers

1. Sealants shall be **PSI-270** as manufactured by **Polymeric Systems Inc., Sikaflex 2C,** as manufactured by **Sika Corporation,** or equal.

F. Sealants for non-waterstop joints in concrete shall be in conformance with the requirements of Section 07 92 13 – Sealants and Caulking.

2.4 JOINT MATERIALS

A. Bearing Pad

1. The bearing pad shall be neoprene conforming to ASTM D 2000 - Standard Classification System for Rubber Products in Automotive Applications, BC 420, 40 durometer hardness, unless otherwise indicated.

B. Neoprene Sponge

1. The sponge shall be neoprene, closed-cell, expanded, conforming to ASTM D 1056 - Flexible Cellular Materials - Sponge or Expanded Rubber, Type 2C5-E1.

C. Joint Filler

1. Joint filler for expansion joints in waterholding structures shall be neoprene conforming to ASTM D 1056, Type 2C5-E1.

2. Joint filler material in other locations shall be of the preformed non-extruding type, constructed of cellular neoprene sponge rubber or polyurethane of firm texture.

3. Bituminous fiber type will not be accepted.

4. Non-extruding and resilient-type preformed expansion joint fillers shall conform to the requirements and tests set forth in ASTM D 1752 - Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction, for Type I, except as otherwise indicated.

2.5 BACKING ROD

A. The backing rod shall be an extruded closed-cell, polyethylene foam rod.

B. The rod material shall be compatible with the joint sealant material and shall have a tensile strength of not less than 40 psi and a compression deflection of approximately 25 percent at 8 psi.

C. The rod shall be 1/8 inch larger in diameter than the joint width except that a one-inch diameter rod shall be used for a 3/4-inch wide joint.

2.6 SLIP DOWELS

A. Slip dowels in joints shall be smooth epoxy-coated bars conforming to ASTM A 775 - Epoxy Coated Reinforcing Steel Bars.

2.7 PVC TUBING

A. PVC tubing in joints shall be SDR 13.5, conforming to ASTM D 2241 - Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).

PART 3 -- EXECUTION

3.1 GENERAL

A. Waterstops shall be embedded in the concrete across joints as indicated.

B. Waterstops shall be fully continuous for the extent of the joint.

C. Splices necessary to provide such continuity shall conform to the printed instructions of the waterstop manufacturer.

D. The CONTRACTOR shall take suitable precautions and provide means to support and protect the waterstops during the progress of the WORK and shall repair or replace any waterstops damaged during progress of the WORK at no additional cost to the OWNER.

E. Waterstops shall be stored so as to permit free circulation of air around the waterstop material.

F. When any waterstop is installed in the concrete on one side of a joint while the other portion of the waterstop remains exposed to the atmosphere for more than 2 Days, suitable precautions shall be taken to shade and protect the exposed waterstop from direct rays of the sun during the entire exposure time until the exposed portion of waterstop is embedded in concrete.

3.2 SPLICES IN PVC WATERSTOPS

A. Splices in PVC waterstops shall be performed by heat sealing the adjacent waterstop sections in accordance with the manufacturer's printed recommendations.

B. It is essential that:

1. The material shall not be damaged by heat sealing.

2. The splices shall have a tensile strength of not less than 80 percent of the unspliced material.

3. The continuity of the waterstop ribs and of its tubular center axis shall be maintained.

4. No edge welding will be accepted.

C. Butt joints of the ends of 2 identical waterstop sections may be made while the material is in the forms.

D. Other Joints

1. Joints with waterstops involving more than 2 ends to be jointed together, and joints that involve an angle cut, alignment change, or the joining of 2 dissimilar waterstop sections, shall be prefabricated prior to placement in the forms, allowing not less than 24-inch-long strips of waterstop material beyond the joint.

2. Upon inspection and approval, such prefabricated waterstop joint assemblies shall be installed in the forms and the ends of the 24-inch strips shall be butt-welded to the straight run portions of waterstop in place in the forms.

E. Where a centerbulb waterstop intersects and is jointed with a non-centerbulb waterstop, care shall be taken to seal the end of the centerbulb, using additional PVC material if needed.

3.3 JOINT CONSTRUCTION

A. Setting Waterstops

1. In order to eliminate faulty installation that may result in joint leakage, particular care shall be taken as to the correct positioning of the waterstops during installation.

2. Adequate provisions shall be made to support and anchor the waterstops during the progress of the WORK and to ensure proper embedment in the concrete.

3. The symmetrical halves of the waterstops shall be equally divided between the concrete pours at the joints.

4. The center axis of the waterstops shall be coincident with the joint openings.

5. Thoroughly work the concrete in the vicinity of joints for maximum density and imperviousness.

B. Waterstop Placement

1. In placing waterstops in the forms, means shall be provided to prevent them from being folded over by the concrete as it is placed.

2. Waterstops shall be held in place with light wire ties on 12-inch centers, which shall be passed through hog rings at the edge of the waterstop and tied to the curtain of reinforcing steel.

3. Horizontal waterstops, with their flat face in a vertical plane, shall be held in place with continuous supports to which the top edge of the waterstop shall be tacked.

4. In placing concrete around horizontal waterstops with their flat face in a horizontal plane, the concrete shall be worked under the waterstops by hand in order to avoid the formation of air and rock pockets.

C. In placing centerbulb waterstops in expansion joints, the centerbulb shall be centered on the joint filler material.

D. Waterstop in vertical wall joints shall terminate 6 inches from the top of the wall, where such waterstop does not connect with any other waterstop and is not to be connected to a future concrete placement.

E. Joint Location

1. Construction joints and other types of joints shall be provided where indicated.

2. If not indicated, construction joints shall be provided at a 25-foot maximum spacing.

3. Where joints are indicated to be spaced greater than 40 feet apart, additional joints shall be provided to maintain the 25-foot maximum spacing.

4. The location of joints, regardless of type, shall be submitted for acceptance by the ENGINEER.

F. Joint Preparation

1. Special care shall be used in preparing concrete surfaces at joints where bonding between 2 sections of concrete is required.

2. Unless otherwise indicated, such bonding shall be required at every horizontal joint in walls.

3. Surfaces shall be prepared in accordance with Section 03 31 00 – Cast-in-Place Concrete.

G. Retrofit Joint Preparation

1. Existing surfaces to receive a retrofit waterstop shall be clean and free from any loose or foreign material.

2. The surface shall be given a light sandblast or hydroblast finish to 1/8-inch amplitude prior to the application of epoxy and waterstop.

H. Construction Joint Sealant

1. Construction joints in water-bearing floor slabs and elsewhere as indicated shall be provided with tapered grooves which shall be filled with a construction joint sealant.

2. The material used to form the tapered grooves shall be left in the grooves until just before the grooves are cleaned and filled with joint sealant.

3. After removing the forms from the grooves, laitance and fins shall be removed, and the grooves shall be sand blasted.

4. The grooves shall be allowed to thoroughly dry, after which they shall be blown out and immediately thereafter, they shall be primed and filled with the construction joint sealant.

5. The primer shall be furnished by the sealant manufacturer, and no sealant shall be used without a primer.

6. Care shall be used to completely fill the sealant grooves.

7. Areas designated to receive a sealant fillet shall be thoroughly cleaned as outlined for the tapered grooves prior to application of the sealant.

I. The primer and sealant shall be placed strictly in accordance with the printed recommendations of the manufacturer, taking special care to properly mix the sealant prior to application.

J. The sides of the sealant groove shall not be coated with bond breaker, curing compound, or any other substance which would interfere with proper bonding of the sealant.

K. The sealant shall achieve final cure at least 7 Days before the structure is filled with water.

L. The sealant shall be installed by a competent waterproofing specialty contractor with a successful record of performance in similar installations.

M. Mixing

1. Catalyst-cured, 2-part materials shall be thoroughly, and uniformly mixed, and special care shall be taken to properly mix the sealer before its application.

2. Before any sealer is placed, the CONTRACTOR shall arrange to have workers performing the WORK carefully instructed on the proper method of mixing and application by a representative of the sealant manufacturer.

N. Failure to Cure

1. Any joint sealant that fails to fully and properly cure after the manufacturer's recommended curing time for the conditions of the WORK shall be completely removed, and the groove shall be thoroughly sandblasted to remove traces of the uncured or partially cured sealant and primer.

2. The groove shall be re-sealed with the indicated joint sealant.

3. Costs of such removal, joint treatment, re-sealing, and appurtenant WORK shall be the CONTRACTOR’s responsibility as part of the WORK.

O. Hydrophilic Waterstop

1. Where a hydrophilic waterstop is indicated, it shall be installed in accordance with the manufacturer's instructions and recommendations except as may be modified in this Section.

2. When requested by the ENGINEER, the CONTRACTOR shall arrange for the manufacturer to furnish technical assistance in the field.

3. Hydrophilic waterstop shall only be used where complete confinement by concrete is provided.

4. Hydrophilic waterstop shall not be used in expansion or contraction joints nor in the first 6 inches of a non-intersecting joint.

5. Location

    a. The hydrophilic waterstop shall be located as near as possible to the center of the joint, and it shall be continuous around the entire joint.

    b. The minimum distance from the edge of the waterstop to the face of the member shall be 5 inches.

6. Placement

    a. Where the thickness of the concrete member to be placed on the hydrophilic waterstop is less than 12 inches, the waterstop shall be placed in grooves formed or ground into the concrete.

    b. The groove shall be at least 3/4-inch-deep and 1-1/4 inches wide.

    c. When placed in the groove, the minimum distance from the edge of the waterstop to the face of the member shall be 2-1/2 inches.

7. Where a hydrophilic waterstop is used in combination with PVC waterstop, the hydrophilic waterstop shall overlap the PVC waterstop for a minimum of 6 inches and shall be adhered to PVC waterstop by a single component water-swelling sealant as recommended by the manufacturer.

8. The hydrophilic waterstop shall not be installed where the air temperature falls below the manufacturer's recommended range.

9. Preparation

    a. The concrete surface under the hydrophilic waterstop shall be smooth and uniform, and the concrete shall be ground smooth if needed.

    b. Alternatively, the hydrophilic waterstop shall be bonded to the surface using an epoxy grout that completely fills voids and irregularities beneath the waterstop material.

    c. Prior to installation, the concrete surface shall be wire brushed to remove any laitance or other materials that may interfere with the bonding of epoxy.

10. Securing

    a. The hydrophilic waterstop shall be secured in place with concrete nails and washers at 12-inch maximum spacing.

b. The above requirement shall be in addition to the adhesive recommended by the manufacturer.

P. Retrofit Waterstop

1. Retrofit waterstops shall be set in a bed of epoxy over a sandblasted surface with stainless steel batten bars and 1/4-inch diameter stainless steel anchors at 6 inches on-center, staggered, and in accordance with the manufacturer's written recommendations.

END OF SECTION

SECTION 03 60 00 – GROUTING

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide grout, complete and in place, in accordance with the Contract Documents.

B. Grout provided as a base support for mechanical and electrical equipment shall conform to manufacturer's requirements and the requirements of this section.

C. The following types of grout are covered in this Section:

1. Non-Shrink Grout

2. High Strength Non-Shrink Grout

3. Non-Shrink Epoxy Grout

4. Topping Grout and Concrete/Grout Fill

1.2 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. ASTM C109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)

B. ASTM C307 -- Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacings

C. ASTM C531 – Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes

D. ASTM C579 – Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes

E. ASTM C580 – Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes

F. ASTM C827 – Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures

G. ASTM C882 - Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear

H. ASTM C1090 – Standard Test Method for Measuring Changes in Height of Cylindrical Specimens from Hydraulic-Cement Grout

I. ASTM C1107 – Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)

J. ASTM C1116 – Standard Specification for Fiber-Reinforced Concrete

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K. ASTM C1339 – Standard Test Method for Flowability and Bearing Area of Chemical-Resistant Polymer Machinery Grouts

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 - Submittal Procedures.

1. Certified testing lab reports for tests indicated herein.

2. Test results and service report from the field tests and the demonstration and training session verifying the requirements indicated herein.

3. Manufacturer’s literature containing instructions and recommendations on the mixing, handling, placement, curing, and appropriate uses for each type of grout used in the WORK, and location of use.

4. Documentation indicating that the grouts contain no chlorides or other chemicals that cause corrosion.

5. Manufacturer’s Safety Data Sheet documenting composition of grouts.

6. Submit manufacturer's written warranty as indicated herein.

7. Name and telephone number of grout manufacturer's representative who will give on-site service. The representative shall have at least one year of experience with the indicated grouts.

1.4 QUALITY ASSURANCE

A. Field Tests

1. Compression test and performance evaluation specimens shall be taken from the first placement of each type of grout. The specimens shall be made by the Contractor’s approved agency per 2015 IBC Section 1704.

2. Compression tests and fabrication of specimens for cement grout and cement based non-shrink grout shall be performed in accordance with ASTM C1107.

3. Compression tests and fabrication of specimens for topping grout and concrete/grout fill shall be performed in accordance with Section 03 31 00- Cast-in-Place Concrete.

4. Compression tests and fabrication of specimens for epoxy grouts shall be performed in accordance with ASTM C579, Method B. A set of 3 specimens shall be made for testing at 7 Days and each earlier time period as appropriate.

5. The cost of laboratory tests on grout will be paid by the CONTRACTOR including where test results show the grout to be defective. In such cases, the CONTRACTOR shall pay for the testing, removal and replacement of Defective Work, and re-testing, all as part of the WORK.

6. The CONTRACTOR shall assist the approved agency in obtaining specimens for testing and shall furnish materials necessary for fabricating the test specimens.

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B. Construction Tolerances: Construction tolerances shall be as indicated in Section 03 31 00 unless indicated otherwise.

C. Pre-Installation Demonstration and Training

1. Non-Shrink Grouts

a. The grout manufacturer shall give a demonstration and training session for the cement based and epoxy non-shrink grouts to be used on the project before any installation of grout is allowed.

b. Training session shall use a minimum of 5 bags of cement-based non-shrink grout mixed to fluid consistency. Tests shall be conducted for flow cone and bleed tests. Six cubes for testing at 1, 3, and 28 Days shall be made. The remaining grout shall be placed, and curing may be initiated on actual project placements such as baseplates to provide on-the-job training for the CONTRACTOR and ENGINEER. The CONTRACTOR employees who will be doing the grouting shall participate in this training and demonstration session. The training session shall include methods for curing the grout.

c. The CONTRACTOR shall transport the test cubes to an independent test laboratory, obtain the test reports, and report these demonstration and training test cube strengths to the ENGINEER.

1.5 SPECIAL CORRECTION OF DEFECTS PROVISIONS

A. Manufacturer's Warranty

1. Furnish one year warranty for WORK provided under this section.

2. Manufacturer's warranty shall not contain a disclaimer limiting responsibility to the purchase price of products or materials.

PART 2 -- PRODUCTS

2.1 APPLICATION

A. Unless indicated otherwise, grouts shall be provided as listed below whether indicated on the Drawings or not.

Application	Type of Grout
Beam and column (1 or 2 story) base plates less than 16-inches in the least dimension.	Non-Shrink
Filling blockout spaces for embedded items such as railing posts, gate guide frames, etc.	Non-Shrink
Toppings and concrete/grout fill less than 3-inches thick	Topping Grout
Toppings and concrete/grout fill greater than 3-inches thick	Structural Concrete Per Section 03 31 00

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Anchor bolts, anchor rods and reinforcing steel required to be set in epoxy or adhesive.	Post-Installed Anchors in Concrete per Section 05 05 19

2.2 NON-SHRINK GROUTS

A. General

1. All non-shrink grout shall be cement based unless otherwise noted.

2. Cement-based non-shrink grout shall be a prepackaged, inorganic, fluid, non-gas liberating, non-metallic, cement type grout requiring only the addition of water. Cement from kilns burning metal-rich hazardous waste fuel shall not be used.

3. Manufacturer's instructions shall be printed on each bag or other container in which the materials are packaged. The specific formulation for each non-shrink grout shall be as recommended by the manufacturer for the particular application.

4. The manufacturer’s product information shall state the acceptability of the non-shrink grout for the intended purpose and location.

5. Grout shall not contain chlorides or additives that may contribute to corrosion.

6. Grout placed in continuously wet environments or in exterior conditions shall not contain gypsum or calcium salt.

7. All cement-based non-shrink grout shall have the following general properties:

   a. Meet the requirements of ASTM C1107.

   b. Have a maximum early age height change of 4.0 percent expansion and shall have no shrinkage (0.0 percent) in accordance with ASTM C827. The grout when tested shall not bleed or segregate at maximum allowed water.

   c. No shrinkage (0.0 percent) and a maximum of 0.3 percent expansion in the hardened state when tested in accordance with ASTM C1090.

   d. A minimum bond strength (concrete to grout) of 1,900 psi per modified ASTM C882.

8. Environmental and ambient conditions shall be a factor in the selection of non-shrink grout. If a non-shrink grout is to be used in a high sulfate environment, marine environment, high temperature environment, or freeze/thaw environment, the manufacturer’s product information shall state the acceptability for each environmental condition.

B. Non-Shrink Grout

1. Non-Shrink Grout shall have a minimum 28 Day compressive strength of 5,000 psi when mixed at a fluid consistency and tested per ASTM C109.

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2. Non-Shrink Grout shall be **Five Star Grout** by **Five Star Products, Five Star Fluid Grout 100** by **Five Star Products, Sikagrout 212** by **Sika Corporation,** or approved equal.

C. High Strength Non-Shrink Grout

1. High Strength Non-Shrink Grout shall have a minimum 28-Day compressive strength of 10,000 psi when mixed at a fluid consistency and tested per ASTM C109.

2. High Strength Non-Shrink Grout shall be **Five Star High Strength Grout** by **Five Star Products, Sikagrout 428 FS,** or approved equal.

2.3 NON-SHRINK EPOXY GROUT

A. Non-shrink epoxy grout shall be a flowable, non-shrink, 100 percent solids system. The epoxy grout system shall have 3 components: resin, hardener, and specially blended aggregate, each premeasured and prepackaged. The resin component shall not contain any non-reactive diluents.

B. The manufacturer's product information shall state the acceptability of the epoxy grout for the intended purpose and location.

C. Variation of component ratios is not permitted unless specifically recommended by the manufacturer. Manufacturer's instructions shall be printed on each container in which the materials are packaged.

D. Resins containing butyl glycidyl ether (BGE) or other highly volatile and hazardous reactive diluents are not acceptable.

E. Non-shrink epoxy grout shall have a negligible (less than 0.0006 in/in) length change after hardening, and a coefficient of thermal expansion less than 0.00003 in/in F when tested in accordance with ASTM C531.

F. Non-shrink epoxy grout shall develop a minimum compressive strength of 9,000 psi in 24 hours and 13,000 psi in seven days when tested in accordance with ASTM C579, method B.

G. The effective bearing area shall be a minimum of 85 percent effective bearing area (EBA) in accordance with ASTM C1339, for bearing area and flow.

H. The chemical formulation of the non-shrink epoxy grout shall be that recommended by the manufacturer for the particular application. Do not reduce aggregate loading or add solvents to increase flowability.

I. Non-shrink epoxy grout shall have the following minimum properties when tested at 7 Days:

1. Minimum bond strength to concrete of 3,000 psi per ASTM C882 modified.

2. Minimum bond strength to steel of 1,700 psi per ASTM C882 modified.

3. Minimum flexural strength of 2,500 psi per ASTM C580.

4. Minimum tensile strength of 2,000 psi per ASTM C307.

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J. Non-shrink epoxy grout shall be **Five Star DP Epoxy Grout** by **Five Star Products, Inc.**, **Masterflow 648** by **BASF Corporation**, **Sikadur 42 Grout-Pak** by **Sika Corporation**, or approved equal.

2.4 TOPPING GROUT AND CONCRETE/GROUT FILL

A. Where fill thickness is 3-inches or greater, structural concrete as indicated in Section 03 31 00 - Cast-in-Place Concrete, may be used when accepted by the ENGINEER. Fiber reinforcing shall be as indicated below.

B. Grout for topping of slabs and concrete/grout fill for built-up surfaces of tanks, channels, and basin bottoms shall be composed of cement, fine aggregate, coarse aggregate, water, and admixtures proportioned and mixed as indicated. Materials and procedures indicated for structural concrete in Section 03 31 00 - Cast-in-Place Concrete, shall apply unless indicated otherwise.

C. Topping grout and concrete/grout fill shall contain a minimum of 564 pounds of cement per cubic yard with a maximum water/cement ratio of 0.45.

D. Coarse aggregate shall be graded as follows:

U.S. Standard Sieve Size	Percent by Weight Passing
1/2 in	100
3/8 in	90-100
No. 4	20-55
No. 8	5-30
No. 16	0-10
No. 30	0

E. Final mix design shall be as determined by trial mix design as indicated in Section 03 31 00, except that drying shrinkage tests are not required.

F. Topping grout and concrete grout/fill shall contain air-entraining agent per Section 03 31 00.

G. Strength: Minimum compressive strength of topping grout and concrete/grout fill at 28 days shall be 4,500 psi.

H. Topping grout where the fill thickness is 3 inches or greater shall contain fiber reinforcing, unless otherwise shown on the Contract Documents. Fiber reinforcing shall be 100 percent virgin polypropylene fibrillated fibers specifically manufactured in a blended gradation for use as concrete secondary reinforcement. Fibers shall be added at a rate of 1.5 pounds per cubic yard of concrete. Fibers shall conform to ASTM C1116.

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2.5 CURING MATERIALS

A. Curing materials shall be in accordance with Section 03 31 00 and as recommended by the manufacturer of prepackaged grouts.

2.6 CONSISTENCY

A. The consistency of grout shall be as necessary to completely fill the space to be grouted for the particular application. Dry pack consistency is defined such that the grout is plastic and moldable but will not flow. Where "dry pack" is called for in the Contract Documents, it shall mean a grout of that consistency; the type of grout to be used shall be as indicated herein for the particular application.

B. The slump for topping grout and concrete/grout fill shall be adjusted to match placement and finishing conditions but shall not exceed 4-inches.

2.7 MEASUREMENT OF INGREDIENTS

A. Measurements for cement grout shall be made accurately by volume using containers. Shovel measurements shall not be allowed.

B. Prepackaged grouts shall have ingredients measured by means recommended by the manufacturer.

PART 3 -- EXECUTION

3.1 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Grout shall be stored in accordance with manufacturer's recommendations.

3.2 GENERAL

A. CONTRACTOR shall arrange for the manufacturer of prepackaged grouts to provide on-site technical assistance within 72 hours of request, as part of the WORK.

B. Grout shall not be placed until base concrete or masonry has attained its design strength, unless authorized otherwise by the ENGINEER.

C. When cementitious grouts are used on concrete surfaces, the concrete surface shall be saturated with water for 24 hours prior to placement. Upon completion of the saturation period, excess water shall be removed with clean, oil free compressed air prior to grouting. Concrete substrate shall not be wet prior to placement of epoxy grouts.

D. Surface preparation, curing, and protection of cement grout shall be in accordance with Section 03 31 00. The finish of the grout surface shall match that of the adjacent concrete unless otherwise indicated.

E. Surfaces that will be in contact with grout shall be free of dirt, loose rust, oil, wax, grease, curing compounds, laitance, loose concrete, and other deleterious materials.

F. Shade the WORK from sunlight for at least 24 hours before and 48 hours after grouting.

G. Contact the grout manufacturer's representative for assistance on hot and cold weather grouting techniques and precautions if applicable.

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3.3 GROUTING PROCEDURES

A. General: Mixing, surface preparation, handling, placing, consolidation, curing, and other means of execution for prepackaged grouts shall be done according to the instructions and recommendations of the manufacturer.

B. Structural, equipment, tank, and piping support bases shall be grouted, unless indicated otherwise.

1. The original concrete shall be blocked out or finished off a sufficient distance below the plate to provide for a minimum one-inch thickness of grout or other thickness if indicated.

2. After the base plate has been set in position at the proper elevation by steel wedges or double nuts on the anchor bolts, the space between the bottom of the plate and the original pour of concrete shall be filled with non-shrink-type grout through a headbox of appropriate size. The mixture shall be of a fluid consistency and poured continuously into the space between the plate and the base concrete. Forms for grout shall be tight against retaining surfaces, and joints shall be sealed as recommended by the grout manufacturer to be liquid-tight. Forms shall be coated as recommended by the grout manufacturer for easy form release. Where this method of placement is not practical or where required by the ENGINEER, alternate grouting methods shall be submitted by the CONTRACTOR for acceptance by the ENGINEER.

3. Concrete equipment pads for equipment bases that will be epoxy-grouted shall be sized so that, when the equipment base is fully grouted, the epoxy grout is stopped not less than 4-inches from the edge of the pad.

C. Topping Grout and Concrete/Grout Fill

1. Mechanical, electrical, and finish WORK shall be completed prior to placement of topping or concrete/grout fill. To ensure bonding to the base slab, the base slab shall be given an exposed aggregate finish. Alternatively, where accepted by the ENGINEER, the base slab shall be given a roughened textured surface by a close-spaced rake while the surface is green. After curing, high pressure washing shall expose the aggregates and produce not less than a 3/16-inch amplitude roughness. Jackhammers or chipping hammers shall not be used.

2. The minimum thickness of grout topping and concrete/grout fill shall be one-inch. Where the finished surface of concrete/grout fill is to form an intersecting angle of less than 45 degrees with the concrete surface it is to be placed against, a key shall be formed in the concrete surface at the intersection point. The key shall be a minimum of 3-1/2 inches wide by 1-1/2 inches deep.

3. The base slab shall be thoroughly cleaned and wetted to saturated surface dry (SSD) condition per the International Concrete Repair Institute (ICRI) -- Technical Guide for Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays, prior to placing topping grout and grout fill. No topping grout shall be placed until the slab is completely free from standing pools or ponds of water. A thin coat of neat cement grout shall be broomed into the surface of the slab just before topping or fill placement. The neat cement grout shall not be allowed to dry before topping placement. If it does dry, it must be immediately removed using wet stiff brooms and reapplied. The topping and fill shall be compacted by rolling or thorough tamping, brought to established grade, and floated. Grouted fill for tank and basin

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bottoms where scraping mechanisms are to be installed shall be screeded by blades attached to the revolving mechanism of the equipment in accordance with the procedures outlined by the equipment manufacturer after the grout is brought to the established grade. Coat surface with evaporation retardant as needed to prevent plastic shrinkage cracks.

4. Topping grout placed on sloping slabs shall proceed uniformly from the bottom of the slab to the top, for the full width of the placement.

5. The surface shall be tested with a straight edge to detect high and low spots which shall be immediately eliminated. When the topping or fill has hardened sufficiently, it shall be steel troweled to a smooth surface free from pinholes and other imperfections. An approved type of mechanical trowel may be used as an assist in this operation, but the last pass over the surface shall be by hand-troweling. During finishing, no water, dry cement, or mixture of dry cement and sand shall be applied to the surface.

6. As soon as topping or fill finishing is completed, coat surface with curing compound. After the topping is set and sufficiently hard in clarifiers and where required by the ENGINEER, the tank shall be filled with sufficient water to cover the entire floor for 14 days.

3.4 CONSOLIDATION

A. Grout shall be placed in such a manner, for the consistency necessary for each application, to assure that the space to be grouted is completely filled.

END OF SECTION

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SECTION 05 05 19 – POST-INSTALLED ANCHORS IN CONCRETE

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Provide post-installed anchors and appurtenances, complete and in place, as indicated in accordance with the Contract documents.

B. Unless otherwise indicated, drilled concrete anchors shall be adhesive anchors.

C. Section Includes:

1. Adhesive anchors
2. Expansion anchors
3. Screw anchors
4. Undercut anchors (dynamic loading)

1.2 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Definitions

1. Epoxy anchors are considered to be adhesive anchors.
2. Expansion anchors, screw anchors, and undercut anchors are considered to be mechanical anchors.

B. References

1. CBC - California Building Code, 2016 Edition
2. ACI 318 – Building Code Requirements for Structural Concrete (ACI 318-19) and Commentary
3. ACI 350 – Code Requirements for Environmental Engineering Concrete Structures and Commentary (ACI 350-20)
4. ACI 355.2 – Qualification of Post Installed Mechanical Anchors in Concrete and Commentary (ACI 355.2-19).
5. ASCE 7 – ASCE Standard ASCE/SEI 7-16 Minimum Design Loads for Buildings and Other Structures
6. ASCE 41-13 - ASCE Standard ASCE/SEI 41-17 Seismic Evaluation and Retrofit of Existing Buildings
7. ICC ES AC 193 – Mechanical Anchors in Concrete Elements
8. ICC ES AC 308 –Post Installed Adhesive Anchors in Concrete Elements

1.3 SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittal Procedures.

B. Submit the following:

1. Product data and technical information

2. Safety Data Sheets (SDS) for adhesives

3. Manufacturer's literature containing installation instructions and appropriate uses for each type of post-installed anchor and location of use

4. Current ICC-ES or IAPMO-UES Evaluation Reports

5. Certification for each installer demonstrating that they have been qualified in accordance with the Quality Assurance requirements below

C. No substitution for the indicated anchors will be considered unless accompanied with an ICC-ES or IAPMO-UES report verifying strength and material equivalency.

D. Complete structural calculations and anchorage details shall be prepared and submitted by the Contractor for all anchors and anchor groups that are shown but not completely detailed (type, size, location, spacing and embedment) on the Contract Documents. Calculations and anchorage details shall be completed and submitted in accordance with Section 01 33 17 – Structural Design, Support, and Anchorage.

1. Where adhesive anchors are used for structural applications (such as dowels between new and existing concrete) and an embedment depth is not shown on the contract documents, the anchor shall be installed in accordance with Method 1 or Method 2 below:

a. Method 1: The minimum depth of embedment shall be greater than or equal to the development length (l_d) determined in accordance with ACI 318 for a cast in place reinforcing bar of the same diameter and grade, unless it can be shown by calculation that the anchor spacing and edge distance is sufficient to develop the tensile strength of the anchor in a lesser depth of embedment. Calculations shall be submitted in accordance with Section 01 33 00 – Submittal Procedures.

b. Method 2: Adhesive anchors in concrete that cannot develop the tensile capacity of the steel element may be used to transfer forces, provided that the loads on the anchor are amplified by the system overstrength factor (Ω_o) in Table 12.2-1 of ASCE 7, or where unreduced forces are used in accordance with ASCE 41 for existing structures. Calculations shall be submitted in accordance with Section 01 33 00 – Submittal Procedures.

1.4 QUALITY ASSURANCE

A. Special inspection for all post-installed anchor installations shall be provided:

1. As recommended or required by the ICC-ES or IAPMO-UES report.

2. As required by the enforceable building code.

3. As otherwise indicated in the Contract Documents.

B. The most stringent of the above requirements shall be used. The cost of Special Inspection of post-installed anchors shall be paid for by the OWNER.

C. Before installing adhesive anchors in the WORK, anchor installers shall be trained and qualified at the Site by the manufacturer's representative. Training and qualification for each installer shall include at least:

1. Hole drilling procedure, hole preparation and cleaning techniques, adhesive injection technique and dispenser training/maintenance, rebar dowel preparation and installation, and proof loading if required.

2. Each installer shall be re-qualified every 6 months for the duration of the project by the same qualifying procedure.

D. Before installing mechanical anchors in the WORK, anchor installers shall be trained and qualified at the Site by the manufacturer's representative. Training and qualification for each installer shall include at least:

1. Hole drilling procedure, hole preparation and cleaning techniques, and torquing.

2. Each installer shall be re-qualified every 6 months for the duration of the project by the same qualifying procedure.

E. Defective anchors noted by the Special Inspector shall be replaced and re-installed by the CONTRACTOR without any additional compensation.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to job site in manufacturer’s or distributor’s packaging undamaged, complete with installation instructions.

B. Protect and handle materials in accordance with manufacturer’s recommendations to prevent damage or deterioration.

C. Anchoring adhesives shall be stored at temperatures prescribed by the manufacturer and must not be used beyond the expiration date.

1.6 SITE CONDITIONS

A. Post-installed anchors shall be installed in concrete having a minimum age of 21 days at time of anchor installation.

B. The anchor or fastener coating, plating, or steel type must provide suitable corrosion resistance for the environment in which the anchor or fastener is installed. Anchors, nuts, and washers in the locations listed below shall be fabricated from type 316 or 304 stainless steel:

1. buried locations

2. submerged locations

3. locations subject to seasonal or occasional flooding

4. inside hydraulic structures below the top of the structure

5. inside buried vaults, manholes, and structures that do not drain through a gravity sewer or to a sump with a pump

6. chemical handling areas

7. inside trenches, containment walls, and curbed areas

8. locations indicated or designated by the ENGINEER to be provided with stainless steel anchors.

PART 2 -- PRODUCTS

2.1 ADHESIVE ANCHORS

A. General

1. The adhesive anchor system shall consist of: 1) adhesive product; and 2) threaded rod or reinforcing bar insert. The complete system shall be compatible as required by the adhesive manufacturer.

2. Adhesives shall be injectable, two-component, cartridge-type systems dispensed and mixed through a static mixing nozzle supplied by the manufacturer.

3. The evaluation report issued by ICC-ES or IAPMO-UES shall state the acceptability of the adhesive anchor for the intended purpose and location.

4. Adhesive anchors shall be permitted when regular ambient temperatures are consistent with manufacturer's recommendation for long and short term temperatures.

5. Adhesive anchors shall not be used where anchors are subject to vibration or fire.

6. Adhesive anchors shall not be used in overhead applications.

7. Where required, adhesive shall be capable of being used in submerged applications once cured.

B. Adhesive Anchors in Concrete

1. Threaded rod inserts shall meet the requirements of 05 50 00 - Miscellaneous Metalwork.

2. Reinforcing dowel inserts shall meet the material requirements of Section 03 21 00 – Reinforcement Steel and 03 31 00 – Cast-in-Place Concrete.

3. Adhesive for use in concrete adhesive anchors shall be certified for use in resisting seismic loads in cracked concrete applications in accordance with ICC-ES AC 308.

4. Where not detailed on the drawings, adhesive anchors shall be designed in accordance with ACI 350 as amended by the specific design provisions of ICC-ES AC 308.

5. Adhesive anchors shall have an evaluation report issued by ICC-ES or IAPMO-UES and shall have been tested and qualified for performance in cracked and uncracked concrete in accordance ICC-ES AC308 to resist static, wind, and earthquake (Seismic Design Categories A through F).

6. Adhesive anchors for concrete shall be Pure110+ by Powers Fasteners, HIT-RE 500 V3 by Hilti or SET-3G by Simpson Strong-Tie, or equal.

2.2 EXPANSION ANCHORS

A. General

1. Expansion anchors are post-installed torque-controlled mechanical expansion anchors used to resist structural loads.

2. Expansion anchors shall be an imperial sized, threaded stud with an integral cone expander, expansion clip, nut and washer.

3. Lead caulking anchors will not be permitted.

4. Non-embedded buried or submerged anchors shall be fabricated from stainless steel.

5. The evaluation report issued by ICC-ES or IAPMO-UES shall state the acceptability of the expansion anchor for the intended purpose and location.

6. Anchors subjected to dynamic or vibratory loading shall be suitable for the intended loading and location as indicated in the manufacturer's technical product data.

B. Expansion Anchors for Concrete

1. Anchors shall be designed in accordance with ACI 318, which requires post-installed mechanical anchors to be qualified according to ACI 355.2.

2. Anchors shall have an evaluation report issued by ICC-ES or IAPMO-UES and have been tested and qualified for performance in cracked and uncracked concrete in accordance with ACI 355.2 and ICC-ES AC193.

3. Expansion anchors shall be Strong-Bolt 2 by Simpson Strong-Tie, Kwik-Bolt TZ by Hilti, Power-Stud+ SD1 by Powers Fasteners, or equal.

2.3 SCREW ANCHORS

A. General

1. Screw anchors used in exterior and corrosive environments shall be fabricated from stainless steel.

2. The evaluation report issued by ICC-ES or IAPMO-UES shall state the acceptability of the screw anchor for the intended purpose and location.

3. Anchors subjected to dynamic or vibratory loading shall be suitable for the intended loading and location as indicated in the manufacturer's technical product data.

B. Screw Anchors for Concrete

1. Anchors shall be designed in accordance with ACI 318 as amended by the specific design provisions of ICC-ES AC193.

2. Anchors shall have an evaluation report issued by ICC-ES or IAPMO-UES and have been tested and qualified for performance in cracked and uncracked concrete in accordance with ICC-ES AC193.

3. Screw anchors for concrete shall be Titen HD THDSS by Simpson Strong-Tie, or equal.

2.4 UNDERCUT ANCHORS

A. General

1. Undercut anchors are post-installed mechanical anchors that require pre-drilling and a special undercut notch configuration cut into the concrete before installation.

2. Self-undercutting anchors are post-installed torque-controlled mechanical anchors that cut their own undercut notch by application of a setting torque that forces a sleeve over a cone.

3. The evaluation report issued by ICC-ES or IAPMO-UES shall state the acceptability of the undercut anchor for the intended purpose and location.

4. Anchors subjected to dynamic or vibratory loading shall be suitable for the intended loading and location as indicated in the manufacturer's technical product data.

5. Undercut anchors used in exterior and corrosive environments shall be fabricated from stainless steel.

B. Undercut Anchors for Concrete

1. Anchors shall be designed in accordance with ACI 318 as amended by the specific design provisions of ICC-ES AC193.

2. Anchors shall have an evaluation report issued by ICC-ES or IAPMO-UES and have been tested and qualified for performance in cracked and uncracked concrete in accordance with ACI 355.2 and ICC-ES AC193.

3. Undercut anchors for concrete shall be HDA-TR or HDA-PR by Hilti, or equal.

PART 3 -- EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. Post-installed anchors shall be installed in strict accordance with the manufacturer's instructions, the ICC-ES or IAPMO-UES report, and project specific design requirements

indicated on the Contract Documents or in the design calculations provided by the CONTRACTOR per Section 1.3.D.

B. Where holes are drilled in concrete, holes shall be accurately and squarely drilled, and the holes shall be cleaned in accordance with the manufacturer's recommendations.

C. Post-installed anchors shall not be installed until the concrete has reached the required 21 days or per manufacturer's requirements, whichever is longer.

D. Acceptable installation and performance temperature ranges shall be verified with manufacturer's literature prior to installation. Minimum substrate temperatures shall be maintained during the full curing period as required by the manufacturer.

E. Adhesive anchors shall not be loaded until the adhesive has reached its indicated strength in accordance with the manufacturer's instructions.

F. The CONTRACTOR shall identify the position of reinforcing steel and other embedded items prior to drilling holes. Care shall be exercised in drilling to avoid damaging existing reinforcing or embedded items. The location of drilled holes shall be adjusted to avoid drilling through or cutting any existing reinforcing bars or embedded items. Notify the COTR if reinforcing steel or other embedded items are encountered during drilling. Take precautions as necessary to avoid damaging prestressing tendons, electrical and communications conduit, and piping.

G. Core drilling of holes is not allowed.

H. Identification of reinforcing steel and/or embedded items, relocation of drilled holes and adjustments or modifications to anchored or fastened items shall be considered part of the WORK and shall be provided at no additional cost to the OWNER.

I. All abandoned drilled holes shall be repaired at no additional cost to the OWNER.

END OF SECTION

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SECTION 05 12 00 - STRUCTURAL STEEL FRAMING

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide structural steel framing and appurtenant metal parts required for permanent connection of the structural steel system, complete and in place, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. References herein to "Building Code" shall mean the International Building Code of the International Code Council (ICC). The edition of the codes adopted as of the date of award of this contract shall apply to the WORK herein.

B. Federal Specifications and Commercial Standards

AISC	Code of Standard Practice for Steel Buildings and Bridges
AISC	Structural Steel Buildings-Allowable Stress Design and Plastic Design
AISC	Allowable Stress Design Specifications for Structural Joints Using ASTM A325 and A490 Bolts approved by the Research Council on Structural Connections of the Engineering Foundation
ASTM A 36	Structural Steel
ASTM A 53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 307	Carbon Steel Bolts and Studs
ASTM A 325	Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A 500	Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A 501	Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
ASTM A 992	Steel for Structural Shapes for Use in Framing
AWS D1.1	Structural Welding Code – Steel

1.3 CONTRACTOR SUBMITTALS

A. Submit in accordance with Section 01 33 00 - Contractor Submittals.

B. Shop Drawings shall conform to AISC recommendations and specifications and shall show all holes, etc. required for other work. Drawings shall include complete details showing members and their connections, anchor bolt layouts, schedules for fabrication procedures, and diagrams showing the sequence of erection.

C. Testing laboratory certifications for shop and field welders shall be submitted in triplicate directly to the ENGINEER with copies to the CONTRACTOR and others as required.

PART 2 -- PRODUCTS

2.1 MATERIALS

A. Structural steel

Wide Flange Shapes	ASTM A 992
Other Shapes, Plates, Bars	ASTM A 36
Pipe, Pipe Columns, Bollards	ASTM A 53, Type E or S, Grade B standard weight unless noted otherwise
HSS	ASTM A 500 Grade B

B. Bolts for connections shall be ASTM A 325, unless indicated otherwise. Bolts used to connect dissimilar metals shall be ASTM A 193 and A 194, Type 316 stainless steel.

C. Welded anchor studs shall be headed concrete anchor studs (HAS), or deformed bar anchors (DBA), or threaded studs (TAS), as indicated on the Drawings and as supplied by **Nelson Stud Welding Company**, **Omark Industries, KSM Fastening Systems Division,** or equal.

D. Structural steel shall be cleaned and coated with System 100 amine cure epoxy in accordance with Section 09 96 00 - Protective Coating.

E. Steel members in contact with aluminum shall be galvanized per Section 05 50 00 - Miscellaneous Metalwork, unless indicated otherwise.

F. Structural members shall be furnished full length without splices unless otherwise indicated or approved by the ENGINEER.

2.2 INSPECTION AND TESTING

A. Shop inspection may be undertaken by the OWNER at its own expense. The CONTRACTOR shall give ample notice to the ENGINEER prior to the beginning of any fabrication so that inspection may be provided. The CONTRACTOR shall furnish facilities for the inspection of materials and workmanship in the shop, and inspectors shall be allowed free access to the necessary parts of the WORK. Inspectors shall have the authority to reject any materials or WORK that does not meet requirements. Inspection at the shop is intended as a means of facilitating the WORK and avoiding errors, but it is expressly understood that it will in no way relieve the CONTRACTOR from responsibility for proper materials or workmanship under this Specification.

B. The OWNER may engage inspectors to inspect welded connections and high-strength bolted connections, and to perform tests and prepare test reports.

1. Ten percent of all butt and bevel welds which extend continuously for 24-inches or less may be completely tested in accordance with AWS D1.1, Part E, Radiographic Testing of Welds, Chapter 6. Butt and bevel welds that extend continuously for more than 24-inches will be spot tested at intervals not exceeding 36-inches.

2. Defective welds shall be corrected or redone and retested at the CONTRACTOR's expense and to the satisfaction of the welding inspector.

3. The CONTRACTOR shall test to failure 3 bolts from each heat lot of bolts furnished to the job to verify compliance with this Specification. The testing laboratory shall be approved by the ENGINEER, and test reports shall be furnished to the ENGINEER in accordance with Section 01 33 00 – Contractor Submittals. In addition, high-strength bolts shall be inspected using one of the methods set forth in the AISC Specification "Structural Joints Using ASTM A 325 or A 490 Bolts."

C. The costs for initial testing will be paid by the OWNER. However, the CONTRACTOR shall pay testing costs for any additional testing and investigation on WORK that proves to be defective. The CONTRACTOR shall supply material for testing at no cost to the OWNER and shall assist the ENGINEER in obtaining material for test samples.

PART 3 -- EXECUTION

3.1 MEASUREMENT

A. The CONTRACTOR shall verify dimensions and shall make any field measurements necessary and shall be fully responsible for accuracy and layout of WORK. The CONTRACTOR shall review the Drawings, and any discrepancies shall be reported to the ENGINEER for clarification prior to starting fabrication.

3.2 FABRICATION

A. Structural steel shall be fabricated in accordance with the Drawings, AISC Specifications, and the Shop Drawings.

B. Materials shall be properly marked and match-marked for field assembly.

C. Where finishing is required, assembly shall be completed including bolting and welding of units, before start of finishing operations.

3.3 CONNECTIONS

A. Shop and field connections shall be bolted or welded as indicated. Connections shall develop full strength of members joined and shall conform to AISC standard connections.

B. Unless otherwise indicated, welds shall conform to ANSI/AISC 360-16 Specification for Structural Steel Buildings.

3.4 WELDED CONSTRUCTION

A. The CONTRACTOR shall comply with the current AWS D1.1 Code for procedures, appearance, and quality of welds and welders, and methods used in correcting Defective WORK. Welded architectural metal that is exposed to view shall have welds ground smooth. Shielded metal arc welding method or gas metal arc welding methods shall be used for welding structural steel.

B. Unless otherwise indicated, butt and bevel welds shall be complete penetration.

3.5 HOLES FOR OTHER WORK

A. Holes shall be provided as necessary or as indicated for securing other WORK to structural steel framing, and for the passage of other WORK through steel framing members. No torch cut holes will be permitted.

3.6 SHOP PAINT PRIMER

A. Shop paint primer shall be applied in accordance with Section 09 96 00 – Protective Coating. Omit shop-applied primer at field weld locations, for the portion of a member to be embedded in concrete, and where galvanizing with no further coating is required.

3.7 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Structural members shall be loaded in such a manner that they may be transported and unloaded without being excessively stressed, deformed, or otherwise damaged.

B. Structural steel members and packaged materials shall be protected from corrosion and deterioration. Material shall be stored in a dry area and shall not be placed in direct contact with the ground. Materials shall not be placed on the structure in a manner that might cause distortion or damage to the members or the supporting structures. Repair or replace damaged materials or structures as directed.

3.8 ERECTION

A. The CONTRACTOR shall comply with the AISC Specifications and Code of Standard Practice, and with indicated requirements.

B. High-strength bolts shall be installed in accordance with the AISC Specification for Structural Joints Using ASTM High-Strength Bolts. The connections shall be the friction type, unless indicated otherwise.

C. Anchor bolts and other connectors required for securing structural steel to inplace WORK and templates and other devices for presetting bolts and other anchors to accurate locations shall be furnished by the CONTRACTOR.

D. The CONTRACTOR shall be responsible for designing and installing any temporary bracing required for the safe erection of structural steel members.

3.9 SETTING BASES AND BEARING PLATES

A. Prior to the placement of non-shrink grout beneath base and bearing plates, the bottom surface of the plates shall be cleaned of all bond-reducing materials, and concrete and

masonry bearing surface shall also be cleaned of all bond-reducing materials and be roughened to improve bonding.

B. Loose and attached baseplates and bearing plates for structural members shall be set on wedges, leveling nuts, or other adjustable devices.

C. Anchor bolts shall be tightened after the supported members have been positioned and plumbed and the non-shrink grout has attained its indicated strength.

D. Baseplates shall be grouted with non-shrink grout to assure full uniform bearing. Grouting shall be done prior to placing loads on the structure.

3.10 FIELD ASSEMBLY

A. Structural frames shall be set accurately to the lines and elevations indicated. The various members shall be aligned and adjusted to form a part of a complete frame or structure before permanently fastening. Bearing surfaces and other surfaces that will be in permanent contact shall be cleaned before assembly. Necessary adjustments to compensate for discrepancies in elevations and alignments shall be performed.

B. Individual members of the structure shall be leveled and plumbed within AISC tolerances.

C. Required leveling and plumbing measurements shall be established on the mean operating temperature of the structure.

3.11 MISFITS AT BOLTED CONNECTIONS

A. Where misfits in bolting are encountered, the ENGINEER shall be immediately notified. The CONTRACTOR shall submit a method to remedy the misfit for review by the ENGINEER. The ENGINEER will determine whether the remedy is acceptable or if the member must be refabricated.

B. Incorrectly sized or misaligned holes in members shall not be enlarged by burning or by the use of drift pins.

C. Correction of misfits is part of the WORK.

3.12 GAS CUTTING

A. Gas cutting torches shall not be used in the field for correcting fabrication errors in the structural framing, except when approved by the ENGINEER. Gas-cut sections shall be finished equal to a sheared appearance.

3.13 TOUCH-UP PAINTING

A. Immediately after erection, field welds, bolted connections, and abraded areas shall be cleaned of the shop paint primer. Touch-up paint primer applied by brush or spray shall be the same thickness and material as used for the shop coat. Galvanized surfaces that have been field welded or damaged shall be repaired in accordance with Section 05 50 00 – Miscellaneous Metalwork.

B. Finish coating of structural steel shall be as indicated in Section 09 96 00 – Protective Coating.

END OF SECTION

SECTION 05 50 00 – MISCELLANEOUS METALWORK

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Provide miscellaneous metalwork and appurtenances, complete and in place, as indicated in accordance with the Contract Documents.

B. Work covered by this section includes stairways, metal grating, checkered plate for covers, ladders, hatches and covers, and vee traps

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Codes

OSHA 1927.10	Fixed Ladders

B. Commercial Standards

AA-M32C22A41	Aluminum Assn.
AASHTO HS-20	Truck Loading
AISC	Manual of Steel Construction
AISI	Design of Light Gauge, Cold-Formed Steel Structural Members
ASTM A 36	Carbon Structural Steel
ASTM A 48	Gray Iron Castings
ASTM A 53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 123	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 193	Alloy Steel and Stainless Steel Bolting Materials for High Temperature Service
ASTM A 194	Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Service
ASTM A 307	Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
ASTM A 325	Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength

ASTM A 500	Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A 992	Steel for Structural Shapes for Use in Building Framing
ASTM F 1554	Standard Specification for Anchor Bolts, Steel, 36, 55 and 105-ksi Yield Strength
ANSI/AWS D1.1	Structural Welding Code - Steel
ANSI/AWS D1.2	Structural Welding Code - Aluminum
ANSI/AWS QC1	Qualification and Certification of Welding Inspectors

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 - Contractor Submittals.

B. Shop Drawings

1. Shop Drawings shall conform to AISC recommendations and specifications, and shall show holes, and the like, as may be required for other parts of the WORK.

2. Shop Drawings shall include complete details of members and connections, anchor bolt layouts, schedules for fabrication procedures, and diagrams for the sequence of erection.

C. Grating

1. Submit layout drawings for grating, showing the direction of span, type and depth of grating, size and shape of grating panels, seat angle details, and details of grating hold down fasteners.

2. Submit load and deflection tables for each style and depth of grating used.

D. Anchor Submittals

1. For post installed anchors in concrete other than powder-drive pins or impact anchors, refer to Section 05 05 19 – Post Installed Anchors in Concrete.

2. For powder-driven pins or impact anchors, complete structural calculations and anchorage details shall be prepared and submitted by the Contractor for all anchors and anchor groups that are shown but not completely detailed (type, size, location, spacing and embedment) on the Contract Documents. Calculations and anchorage details shall be signed and stamped by a Professional Engineer registered in the state in which the project is located.

1.4 QUALITY ASSURANCE

A. Weld procedures and welder qualifications shall be available in the CONTRACTOR's field office for review.

PART 2 -- PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Steel

Wide Flange Shapes	ASTM A 992
Shapes, Plates, Bars	ASTM A 36
Pipe, Pipe Columns, Bollards	ASTM A 53, Type E or S, Grade B standard weight unless indicated otherwise
HSS	ASTM A 500 Grade B

B. Corrosion Protection

1. Unless otherwise indicated, fabricated steel metalwork which will be used in a corrosive environment and/or will be submerged in water or wastewater shall be coated in accordance with the requirements of 09 96 00 - Protective Coatings, System FM-8, and shall not be galvanized prior to coating.

2. Other miscellaneous steel metalwork shall be hot-dip galvanized after fabrication.

C. Stainless Steel

1. Unless otherwise indicated, stainless steel metalwork and bolts shall be fabricated from Type 316 stainless steel.

D. Aluminum

1. Unless otherwise indicated, aluminum metalwork shall be fabricated from Alloy 6061-T6.

2. Aluminum in contact with concrete, masonry, wood, porous materials, or dissimilar metals shall have contact surfaces coated in accordance with the requirements of Section 09 96 00 - Protective Coatings.

E. Cast Iron

1. Unless otherwise indicated, iron castings shall conform to the requirements of ASTM A 48, Class 50B, or better.

2.2 METAL STAIRS

A. Metal Stairs

1. Metal stairs shall be composed of steel or aluminum stringers and supports, shall be fabricated in accordance with the standard practice of the National Association of Ornamental Metal Manufacturers, and shall be as indicated.

2. Steel stair members shall be hot-dip galvanized after fabrication.

2.3 GRATING STAIR TREADS

A. Grating stair treads shall be designed to support a live load of 100 psf or a concentrated load at mid-span of 300 pounds, whichever creates the higher stress.

B. The maximum deflection due to the uniform live load shall be as required for metal grating, below.

C. Grating stair treads shall be provided with an integral non-slip nosing.

2.4 LADDERS

A. Materials

1. Ladders which may be partially or wholly submerged or which are located inside a hydraulic structure shall be fabricated entirely of Type 316 stainless steel.

2. Other ladders shall be fabricated from carbon steel, hot-dip galvanized after fabrication

B. Pop-Up Extension

1. Every ladder that does not have an exterior handhold shall be equipped with a pop-up extension.

2. The pop-up extension device shall be manufactured of the same material and finish as the ladder, and shall be provided with a telescoping tubular section that locks automatically when fully extended.

3. Upward and downward improvement shall be controlled by stainless steel spring balancing mechanisms.

4. The units shall be completely assembled with fasteners for securing to the ladder rungs in accordance with the manufacturer's instructions.

2.5 METAL GRATING

A. General

1. Metal grating shall be of the indicated design, size, and type.

2. Grating shall be supported around an opening by support members.

3. Where grating is supported on concrete, unless otherwise indicated provide embedded support angles that match the grating material and are mitered and welded at their corners.

4. Banding

a. The grating shall be completely banded at edges and cutouts.

b. The banding material and cross-section shall be equivalent to the bearing bars.

c. The banding shall be welded to each cut bearing bar.

5. The grating pieces shall be fastened to each support in 2 locations.

6. Where grating forms the landing at the top of a stairway, the edge of the grating that forms the top riser shall have an integral non-slip nosing with a width equal to that of the stairway.

7. Where the grating depth is not indicated, provide grating within allowable stress levels and which shall not exceed a deflection of 1/4 inch or the span divided by 180, whichever is less.

8. Design Loading

   a. For standard duty plank and safety grating, the loading to be used for determining stresses and deflections shall be the uniform live load of the adjacent floor or 100 psf, whichever is greater, or a concentrated load of 1,000 pounds.

   b. For heavy duty grating, the loading used for determining stresses and deflections shall be in accordance with AASHTO HS-20.

B. Material

1. Except where indicated otherwise, bar grating shall be fabricated entirely of:

   a. aluminum

2. Safety grating shall be fabricated from aluminum.

3. Plank grating shall be fabricated from aluminum.

4. Grating that may be partially or wholly submerged shall be fabricated from aluminum

C. Standard-Duty Grating

1. No single piece of grating shall weigh more than 80 pounds, unless indicated otherwise.

2. Standard duty grating shall be composed of serrated bar grating.

3. Cross bars shall be welded or mechanically locked tightly into position such that there is no movement between the bearing and cross bars.

1. grating may have a standard mill finish.

2.6 CHECKERED PLATE

A. Checkered plate shall be provided with a pattern of raised lugs on one face and shall be smooth on the opposite face.

B. Lugs

1. Lugs shall be a minimum of one inch in length and raised a maximum of 1/2 inch above the surface.

2. The lugs shall be located in a pattern in which the lugs are oriented at 90 degrees from the adjacent lugs in 2 orthogonal directions.

3. The rows of lugs shall be oriented at 45 degrees from the edges of the plates.

C. Where no material is indicated, the plates shall be fabricated from aluminum.

D. Unless indicated otherwise, the minimum plate thickness shall be as required to limit deflection resulting from a live load of 100 psf to 1/4 inch, or the span divided by 240, whichever is less.

2.7 HATCHES

A. Hatch shall be flush-type, unless indicated otherwise.

B. Hatches shall be fabricated from aluminum 5086 H34, 6063-T5 or 6061-T6, unless otherwise indicated.

C. Hatch hardware shall be fabricated from Type 316 stainless steel and shall be of the gutter-type.

D. The design live load shall be 300 psf, unless indicated otherwise.

E. Configuration

1. Hatch opening sizes, number and swing direction of door leaves, and locations shall be as indicated.

2. Indicated sizes are for the clear opening.

3. Where the number of leaves is not indicated, openings larger than 42 inches in either direction shall be provided with double-leaf doors.

4. Unless indicated otherwise, hinges shall be located on the longer dimension side.

5. Unless indicated otherwise, ladder hatches shall be a minimum of 30 inches wide by 36 inches long, with the ladder centered on the shorter dimension and the door hinge opposite the ladder.

F. Door leaves shall be fabricated from a minimum of 1/4-inch thick checkered-pattern plate.

G. Channel or angle frames shall be fabricated from a minimum 1/4-inch material with an anchor flange around the perimeter.

H. Provide two hatch keys for each hatch secured to a 24" galvanized steel loop-to-loop aircraft cable lanyards.

I. Hatches shall be provided with an automatic hold-open arm with release handle. and shall be designed for easy opening from both inside and outside.

J. Submersible Pump Station Hatches

1. Hatches for submersible pump stations shall include a **Unistrut**, or equal, channel around the frame perimeter.

2. The face of the channel shall be flush with the face of the frame, and shall be compatible with the upper guide rail bracket of the submersible pump.

K. Hatches shall be designed to be water-tight and shall be equipped with a joint gutter, a moat-type edge drain, and drain piping of the length and size necessary to remove the drain water from all dry spaces accessed by the hatch.

1. A joint gutter is not required for hatches in the metal decking for at the reuse pump station for access to the UV units.

L. A minimum 1-1/2 inch diameter drain connection shall be provided, located by the manufacturer.

M. Hatches shall be **Bilco Type J, JD or KD, Babcock-Davis Type B-FGA**, or equal.

2.8 VEE TRAPS (ME-12, ME-13, and ME-14)

A. **General**: VEE traps shall be designed, fabricated, and installed to operate in accordance with the Contract Documents and as described herein using 6061 or 6063 T-5 or T-6 Aluminum.

B. Rods and tubes for the traps shall be fully welded as shown with all welds ground smooth to prevent fish injuries. Rods shall limit gaps to ½" or less. All welded connections shall be ground smooth to prevent fish injuries.

2.9 BOLTS AND ANCHORS

A. Standard Service (Non-Corrosive Application)

1. Bolts, anchor rods, anchor bolts, washers, and nuts shall be fabricated from steel as indicated.

2. Threads on galvanized bolts, rods and nuts shall be formed with suitable taps and dies such that they retain their normal clearance after hot-dip galvanizing.

3. Except as otherwise indicated, steel for bolt material, anchor rods, anchor bolts, and cap screws shall be in accordance with the following requirements:

a. Structural Connections: ASTM A 307, Grade A or B, hot-dip galvanized

b. Headed Anchor Rods and Anchor Bolts: ASTM F1554, Grade 36, hot-dip or mechanically galvanized with Grade A matching nuts

c. High-Strength Bolts, where indicated: ASTM A 325

d. Pipe and Equipment Flange Bolts: ASTM A 193, Grade B-7

B. Corrosive Service

1. Bolts, anchor rods, anchor bolts, nuts, and washers in the locations listed below shall be fabricated from stainless steel as indicated.

    a. buried locations, except pipe fittings and accessories

    b. submerged locations

    c. locations subject to seasonal or occasional flooding

    d. inside hydraulic structures below the top of the structure

    e. inside buried vaults, manholes, and structures that do not drain through a gravity drain pipe or to a sump with a pump

    f. chemical handling areas

    g. inside trenches, containment walls, and curbed areas

    h. locations indicated or designated by the ENGINEER to be provided with stainless steel bolts

C. Unless otherwise indicated, stainless steel bolts, anchor rods, anchor bolts, nuts, and washers shall be fabricated from Type 316 stainless steel, Class 2, conforming to ASTM A 193 for bolts and to ASTM A 194 for nuts.

D. Coating

1. Threads on stainless steel bolts and rods shall be protected with an antiseize lubricant suitable for submerged stainless steel bolts, meeting government specification MIL-A-907E.

2. Buried bolts in poorly drained soil shall be coated the same as the buried pipe.

3. Antiseize lubricant shall be classified as acceptable for potable water use by the NSF.

4. Antiseize lubricant shall be "PURE WHITE" by **Anti-Seize Technology,** Franklin Park, IL, 60131, **AS-470** by **Dixon Ticonderoga Company,** Lakehurst, NJ, 08733, or equal.

E. Bolt Requirements

1. The bolt and nut material shall be free-cutting steel.

2. The nuts shall be capable of developing the full strength of the bolts.

3. Threads shall be Coarse Thread Series conforming to the requirements of the American Standard for Screw Threads.

4. Bolts and cap screws shall have hexagon heads and nuts shall be Heavy Hexagon Series.

5. Bolts and nuts shall be installed with washers fabricated from material matching the base material of bolts, except that hardened washers for high-strength bolts shall conform to the requirements of the AISC Specification.

6. Lock washers fabricated from material matching the bolts shall be installed where indicated.

7. The length of each bolt shall be such that the bolt extends at least 1/8 inch beyond the outside face of the nut before tightening, except for anchor bolts which shall be flush with the face of the nut before tightening.

F. Adhesive Anchors

1. General

a. Unless otherwise indicated, drilled concrete or masonry anchors shall be adhesive anchors.

b. No substitutions will be considered unless accompanied with a current ICC-ES or IAPMO-UES report verifying strength and material equivalency.

2. Epoxy Anchors

a. Epoxy adhesive anchors are required for drilled anchors for outdoor installations, in submerged, wet, splash, overhead, and corrosive conditions, and for anchoring handrails and reinforcing bars.

b. Epoxy shall be in accordance with the requirements of Section 03 60 00 - Grouting.

c. Threaded rod shall be galvanized for general purpose applications and fabricated from Type 316 stainless steel for use in corrosive applications.

d. Epoxy anchors shall not be permitted in areas where the concrete temperature is in excess of 100 degrees F or higher than the limiting temperature recommended by the manufacturer, whichever is lower.

e. Epoxy anchors shall not be used where anchors are subject to vibration or fire.

f. Minimum substrate temperatures shall be maintained during the full curing period as required by the manufacturer.

3. Unless otherwise noted, threaded rod shall be galvanized steel.

G. Expanding-Type Anchors

1. Expanding-type anchors, if indicated or permitted, shall be galvanized steel unless otherwise noted, shall be of the expansion type, and shall be **Simpson Strong-Tie Strong-Bolt 2** anchors, **Hilti Kwik-Bolt TZ anchors, Powers Power-Stud+ SD1 or SD2 anchors,** or equal.

2. Lead caulking anchors will not be permitted.

3. Minimum size shall be as indicated on the Contract Documents.

4. Non-embedded buried or submerged anchors shall be fabricated from stainless steel.

H. Non-Shrink Grouted Anchors

1. Grouted anchors, if indicated or permitted, shall be grouted with a non-shrink cementitious grout in accordance with the manufacturer's recommendations.

2. Non-shrink grout material shall be Class B or C in accordance with Section 03 60 00 - Grouting

PART 3 -- EXECUTION

3.1 FABRICATION AND INSTALLATION REQUIREMENTS

A. **Fabrication and Erection:** Except as otherwise indicated, the fabrication and erection of structural steel shall conform to the requirements of the American Institute of Steel Construction "Manual of Steel Construction."

B. Aluminum Railings

1. Aluminum railing fabrication and installation shall be performed by craftsmen experienced in the fabrication of architectural metalwork.

2. Exposed surfaces shall be free from defects or other surface blemishes.

3. Dimensions and conditions shall be verified in the field.

4. Joints, junctions, miters, and butting sections shall be precision fitted with no gaps occurring between sections, and with surfaces flush and aligned.

5. Electrolysis protection of materials shall be provided.

C. Unless otherwise indicated, provide a 1/2-inch drain line to the nearest floor drain for floor hatches.

3.2 WELDING

A. Method

1. Welding shall be performed by the metal-arc method or gas-shielded arc method as described in the American Welding Society "Welding Handbook" as supplemented by other pertinent standards of the AWS.

2. The qualification of the welders shall be in accordance with the AWS Standards.

B. Quality

1. In assembly and during welding, the component parts shall be adequately clamped, supported, and restrained in order to minimize distortion and for control of dimensions.

2. Weld reinforcement shall be as indicated by the AWS Code.

3. Upon completion of welding, remove weld splatter, flux, slag, and burrs left by attachments.

4. Welds shall be repaired in order to produce a workmanlike appearance, with uniform weld contours and dimensions. Sharp corners of material that is to be painted or coated shall be ground to a minimum of 1/32 inch on the flat.

3.3 GALVANIZING

A. Structural steel plates shapes, bars, and fabricated assemblies required to be galvanized shall, after the steel has been thoroughly cleaned of rust and scale, be galvanized in accordance with the requirements of ASTM A 123.

B. Any galvanized part that becomes warped during the galvanizing operation shall be straightened.

C. Bolts, anchor rods, anchor bolts, nuts, and similar threaded fasteners, after being properly cleaned, shall be galvanized in accordance with the requirements of ASTM A 153.

D. Field Repairs

1. Field repairs to damaged galvanizing shall be performed by preparing the surface and applying a coating.

2. Surface preparation shall consist of removing oil, grease, soil, and soluble material by cleaning with water and detergent (SSPC SP1) followed by brush-off blast cleaning (SSPC SP7) over an area extending at least 4 inches into the undamaged area.

3. The coating shall be applied to at least 3 mils dry film thickness, and shall be **Zinc-Clad XI** by **Sherwin-Williams**, **Galvax** by **Alvin Products**, **Galvite** by **ZRC Worldwide**, or equal.

3.4 DRILLED ANCHORS

A. Drilled anchors and reinforcing bars shall be installed in strict accordance with the manufacturer's instructions.

B. Holes shall be roughened with a brush on a power drill, and then cleaned and dried.

C. Drilled anchors shall not be installed until the concrete has reached the required 28-day compressive strength.

D. Adhesive anchors shall not be loaded until the adhesive has reached its indicated strength in accordance with the manufacturer's instructions.

E. Existing reinforcing steel in the vicinity of proposed holes shall be located prior to drilling. The location of holes shall be adjusted to avoid drilling through or cutting any existing reinforcing bars.

F. All abandoned drilled holes shall be filled with Epoxy Anchor Grout.

END OF SECTION

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SECTION 05 52 00 - ALUMINUM RAILINGS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide component aluminum railing WORK, complete and in place, in accordance with the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals.

B. Shop Drawings: Include railing layouts, post locations, and spacings, gate locations, removable railing sections, connectors, construction details, manufacturer's engineering data, installation instructions, and product data.

C. Calculations: Engineering structural calculations for railings, handrail brackets, brackets, support flanges, and fasteners or anchors.

PART 2 -- PRODUCTS

2.1 SYSTEM DESIGN AND STRUCTURAL PERFORMANCE OF RAILING COMPONENTS

A. General: All railings and installation shall be in accordance with the manufacturer's published recommendations and specifications.

B. Code Requirements: Railings, guardrails, and handrails shall conform to the code requirements for the State-approved OSHA for industrial-commercial, non-public use unless otherwise indicated.

C. Loading Conditions: Railings and handrail brackets shall be capable of withstanding either of the following loading conditions without exceeding the allowable working stress of the material and without permanent deformation.

1. A 200 pound concentrated load applied to any point in any direction.

2. A 50 pound per linear foot loading applied perpendicular to the top rail.

D. The allowable working stress shall be 60 percent of the material yield stress for materials that are more than 3-inches from a weld and 40 percent of the yield stress for all materials within 3-inches of any weld.

2.2 MATERIALS

A. Rail Section: Railings and handrails shall be round tube and round picket and round pipedesign railing system unless otherwise indicated.

B. Rail Material: Aluminum shall be U.S. Alloy 6061 or 6063, T-5 or T-6. Aluminum pipe rail shall be not less than 1-1/2 inch diameter, Schedule 40 pipe.

C. Isolation from Concrete: Electrolysis protective material shall be in accordance with Section 09 96 00 - Protective Coating.

D. Sleeves: Sleeves shall be formed with galvanized steel. Sleeves for removable posts shall be of steel, hot-dip galvanized after fabrication. Galvanizing of steel sleeves shall be done after fabrication to prevent raw steel from being exposed to the elements.

E. Fasteners: Fasteners, screws, and bolts shall be concealed and shall be of stainless steel or aluminum. Handrail bracket fasteners and fasteners over water basins shall be of stainless steel.

F. Brackets: Handrail brackets shall be aluminum with a finish that matches the handrail or railing of which they are a part.

G. Kickplates: Kickplates shall be extruded (match railing system) aluminum of not less than 4 inches in height. Kickplates for pipe railing shall be a channel section for strength.

H. Grout: Non-shrink grout for handrail posts shall consist of an inorganic, non-metallic, premixed grout in accordance with Section 03 60 00 - Grouting with a minimum 28 day compressive strength of 4,000 psi.

2.3 FINISHES

A. Pipe Railing System: Pipe railing system including handrails, railings, tube caps, and other miscellaneous parts of rails shall be provided with an Architectural Class I, 0.7-mil clear anodized finish, AA-M12.

2.4 SUB-ASSEMBLIES

A. Height Requirements: Top of upper railing shall be 42-inches above the working surface. Kickplates shall be installed not more than 1/4-inch off the working surface and shall be provided where indicated and/or required by codes or Reference Standards.

B. Round Sections: Round tube and round picket railings shall be sleeve mounted unless otherwise indicated. Posts shall be not less than 1-1/2 inch diameter, Schedule 40 pipe or 1-1/2 inch by 2-inches oval section. The posts shall be evenly spaced at not less than 4-feet nor more than 5-feet on centers. Field conditions may require some adjustment of spacing. Top rails and railings shall be not less than 1-1/2 inch OD pipe. Rails may be type with bottom enclosures. Bottom rails shall be not less than 1-1/2 inch OD pipe or 1-7/8 inch diameter extrusion with bottom enclosures. The top railings shall be as long as possible and the post shall not project through the top rails. Kickplate of picket rails shall be a specially extruded, snap-in bottom rail enclosure with kickplate or special extruded centered kickplate that is screw applied to bottom of the bottom rail.

C. Guardrails: Guardrails shall be a 2 rail system with equal open spaces between rails (and kickplate when required) with no open space larger than 21-inches as required by IBC.

2.5 MANUFACTURERS, OR EQUAL

A. Round Pipe Railings

1. **"C-V Pipe Rail"** by **CraneVeyor Corp.**

2. **"Wesrail"** by **Moultrie Manufacturing Co.**

B. Rectangular Tube and Square Picket Railings

1. **"Balustrade"** (or Picket) by **ATR Technologies, Inc.**

2. **"Railtec 400"** vertical bar railing by **CraneVeyor Corp.**

C. Round Tube and Round Picket Railings

1. **Oval-Tube Railing "1J"** (with bottom fillers) by **ATR Technologies, Inc.**

2. **"Baluster Railing",** by **CraneVeyor Corp.**

3. **"Wesrail"** by **Moultrie Manufacturing Co.**

PART 3 -- EXECUTION

3.1 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Delivery of Materials: Manufactured materials shall be delivered in original, unbroken packages, containers, or bundles bearing the label of the manufacturer.

B. Storage: All materials shall be carefully stored in a manner that will prevent damage and in an area that is protected from the elements.

3.2 COMPONENT SYSTEMS

A. Unless otherwise indicated, aluminum handrails and railings shall be component systems, installed complete and ready for use with all anchors, attachments, balusters, brackets, caps, fasteners, gates, posts, sleeves, trim, and all other related items required or necessary for the complete installation.

3.3 CRAFTSMANSHIP

A. WORK shall be performed by craftsmen experienced in the fabrication of architectural metalwork. Exposed surfaces shall be free from defects or other surface blemishes. Dimensions and conditions shall be verified in the field in advance. Joints, junctions, miters, and butting sections shall be precision-fitted, with no gaps occurring between sections, and all surfaces shall be flush and aligned and without sharp edges.

3.4 ALIGNMENT

A. Extruded, case, molded, or bent work shall be straight with true edges. Railings and handrails shall be provided with continuous top rails, without post projections or other obstructions.

3.5 EXPANSION/CONTRACTION

A. Railings shall provide expansion joints in the railing at all expansion joints in the structure. In addition exterior railing systems shall provide for 1/4-inch expansion and contraction per 20 linear feet of railing, and interior railing systems shall provide for 1/8-inch expansion

or contraction per 20 linear feet of railing. Expansion joints shall be carefully aligned and without sharp edges.

3.6 FASTENER FINISH

A. Stainless steel fasteners shall be painted to match adjacent aluminum finishes.

3.7 RAILING CONTINUITY AND END TREATMENT

A. Handrails and railings shall be designed to form a continuous run system with elbow turns and bends that do not have interferences with hand movement. Handrails shall be continuous for the full length of the stairs and landings. The handrails shall extend not less than 12-inches beyond the top and bottom risers. Whenever possible, the extension shall be at least 18-inches for the possible use by handicapped people. The ends of handrails shall be returned to wall or shall be terminated in newel posts or safety terminals. Newel posts and safety terminals may be used only when approved by the ENGINEER.

3.8 GATES AND REMOVABLE SECTIONS

A. Gates shall be provided with self-closing hinges and self-closing latch bolts. Removable handrail sections shall be provided where indicated. The gate and removable railing hardware's color shall match that of the railing system of which it is a part.

B. Aluminum items in contact with concrete or steel or embedded in concrete shall be provided with an electrolysis protective material. The protective material shall be applied to the aluminum surface that will be in contact with the dissimilar material.

C. Handrail posts installed into sleeves shall be provided with weep holes between 1/2-inch and 1/4-inch above the finish deck for condensation drainage.

END OF SECTION

SECTION 05 59 00 – FISH SCREENS

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall provide stainless steel or aluminum, removable screens in accordance with the requirements of the Contract Documents. The section also includes requirements for removal bulkhead panels for the Intermediate Raceways.

1.2 DESCRIPTION

A. This section covers the contract item which includes the following:

1. Furnishing, installing, and testing at the locations shown.

2. The removable screens shall include the following:

a. All screens are framed with extruded stainless steel or aluminum frame with measurements in accordance with the drawings.

b. Provide Ultra High Molecular Weight (UHMW) guide inserts where shown.

c. Lifting eye(s) to allow each screen to be lifted in and out of the water, where shown.

d. Carbon steel or aluminum guide channels as shown in the Contract Documents.

B. Screen locations and descriptions include the following:

a. Screen Channel diagonal screen wall, consists of seven (7) perforated plate screens and seven (7) bulkhead panels. Interchangeable.

b. Fish Counter Dewatering Screen assembly consisting of a single wedgewire angled screen insert located upstream of the fish counter. See details on drawings.

c. Lower Raceway Upwell/Upflow Boxes Diffuser Screen – One (1) horizontally mounted, stainless steel profile bar screens at upwell location under the Spawning Shed. Screens are interchangeable. See details in drawings.

d. Lower Pond Upwell/Upflow Boxes Diffuser Screen – One (1) horizontally mounted stainless steel profile bar screen at upwell location in earthen pond. See details in drawings

e. Lower Pond and South Lower Raceway drain end screens. Interchangeable screens with the exception of two (2) smaller screen panels used at the Lower Pond.

f. Reuse Pump Station Intake Screen – Single perforated plate screen. See details on drawings. The Reuse Pump Station Intake Screen extends the full depth of the tailrace.

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g. Tailrace Diffuser Screen – Single perforated plate screen. See details on drawings.

C. The equipment furnished shall be fabricated, assembled, erected, and placed in proper operating conditions in conformity with approved detail drawings, specifications, engineering data, and recommendations of the equipment manufacturer.

1.3 REFERENCES

A. The following publications form a part of this specification to the extent referenced.

1. American Society for Testing and Materials (ASTM):

a. ASTM A 36 – Standard Specification for Carbon Structural Steel.

b. ASTM A 276 – Specifications for Stainless Steel Bars and Shapes.

c. ASTM B 209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

d. ASTM B 221 – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes

2. American Welding Society:

a. AWS D1.1 – Structural Welding Code – Steel.

b. AWS D1.2 – Structural Welding Code – Aluminum.

c. AWS D1.6 – Structural Welding Code – Stainless Steel.

1.4 CONTRACTOR SUBMITTALS

A. Submit the following:

1. Product data, make, model of manufactured components. To include: screen general arrangement of system components; physical dimensions and weights of components; and any required coatings

2. General arrangement drawings of the removable screens, including the layout and configuration.

3. Construction materials used in the project, including product data sheets and other material used in the project.

4. List of spare parts to be furnished.

5. Welder certifications using stainless steel or aluminum and carbon steel as appropriate.

PART 2 -- PRODUCTS

2.1 LOWER RACEWAY UPWELL/UPFLOW SCREEN

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A. General:

1. The removable stainless steel screen and frame shall be designed to cover the Lower Raceway supply pipe upwell box opening, to prevent the entry of juvenile fish while allowing the flow to be evenly distributed across the surface area. When the screen is installed it shall seal over the upwell box area.

2. Screen dimensions and characteristics are shown in the drawings.

3. The removable screens shall be designed and furnished by a single supplier with demonstrated experience with similar screening systems; Hendrick Screens, Elgin Screens, or approved equal.

2.2 LOWER POND UPWELL/UPFLOW SCREEN

A. General

1. The removable stainless steel screen and frame shall be designed to cover the Lower Raceway supply pipe upwell box opening, to prevent the entry of juvenile fish while allowing the flow to be evenly distributed across the surface area. When the screen is installed it shall seal over the upwell box area.

2. Screen dimensions and characteristics are shown in the drawings.

3. The removable screens shall be designed and furnished by a single supplier with demonstrated experience with similar screening systems; Hendrick Screens, Elgin Screens, or approved equal.

2.3 FISH COUNTER DEWATERING SCREEN:

1. The removable angled stainless steel screen and frame shall be designed to bridge the gap from the Intermediate Raceways drain end box to the fish counter. The screen shall be capable of dewatering all flow from the drain end box.

2. Screen dimensions and characteristics are shown in the drawings.

2.4 ALL OTHER SCREENS:

A. General:

1. Screen materials, dimensions, and characteristics are shown in the drawings.

2.5 MATERIALS

A. Materials shall conform to the following:

1. The Upwell/Upflow Box diffuser screens shall be fabricated from ASTM A 276, Type 304 stainless steel.

    a. Stainless steel bolting materials shall conform to ASTM A 193.

2. Fish Counter Dewatering Screen, ASTM A 276, Type 304 stainless steel.

    a. Stainless steel bolting materials shall conform to ASTM A 193.

3. All other screens shall be fabricated from Alloy 5052 Aluminum.

a. Stainless steel bolting materials shall conform to ASTM A 193.

B. **Tolerances:** The CONTRACTOR shall design and fabricate the Fish Screen panel assemblies and Blank panel assemblies so as to ensure that the completed assembled panels are within the tolerances specified below while under a no load conditions in the installed orientation.

1. The panel assembly surface shall be flat to within 1/8 inch plus or minus when measured using a 4-foot straightedge at any location or orientation on the screen face.

2. The diagonal dimensions of the panels shall be within 1/8 inch.

3. The front face of the installed panels to the finish surface of the adjacent support column or wall shall be 1/16 inch plus or minus.

4. Panel width shall be within 1/16 inch plus or minus.

5. The maximum gap between a panel assembly, and the bottom of the structure, the guide slots, or floor, is 1.75 mm.

2.6 PERFORMANCE STANDARDS

A. Exposed surfaces of all screens shall be smooth to the touch.

PART 3 -- EXECUTION

3.1 FABRICATION AND WORKMANSHIP

A. Metalwork shall be free from warp, twists, dents, buckle and other defects. Installation shall be neat, plumb, square, straight and in alignment. Provisions shall be made for expansion throughout to avoid damage. Surfaces shall be cleaned and left free from stains, marks, burrs, or other defects.

B. Welding on the fish screen units shall be in accordance with AWS D1.6 for stainless steel or AWS D1.2 for aluminum. Field welding and cutting operations shall be performed with tarps or shields to prevent slag or other debris from falling in the water

3.2 QUALITY ASSURANCE

A. Welders and welding operators shall be qualified in accordance with AWS D1.6 and D1.2 as appropriate. Procedure qualification tests shall be performed on samples of steel that matches the steel to be used in this section.

3.3 INSTALLATION

A. **General:** Prior to initial installation each panel assembly shall be completely assembled and dimensions verified. If a panel assembly does not fit properly corrective measures shall be taken by the contractor to adjust, trim or reset the frame or mounting surfaces.

B. Installation Procedures

1. UHMW pads on the screen panels and blank panels shall be machined as required to achieve gaps of less than 1.75mm at all joints and edges when assembled. No gaps greater than 1.75mm or holes greater than 3/32” diameter shall be allowed.

2. If a panel assembly does not fit properly, corrective measures shall be taken by the CONTRACTOR to adjust, trim, or reset the panels.

C. **Marking:** All screen panels shall be marked with a permanent stamp or etched on the outside face of the panels at the top. Numbers shall be minimum 1 ½” in height.

END OF SECTION

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SECTION 05 59 10 - DEWATERING SCREEN ASSEMBLY

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall provide a stainless steel Dewatering Screen Assembly as shown and specified, in accordance with the Contract Documents. The assembly shall consist of a dewatering screen panel and support frame welded or fastened together as a unit assembly and mounted to the structural platform in the fish counter basin .

1.2 QUALITY ASSURANCE

A. Manufacturer's Experience: Manufacturer shall have a record of at least 5 years of successful, troublefree operation in similar applications and size equal or larger than the equipment in this Contract.

1.3 CONTRACTOR SUBMITTALS

A. Submit complete shop drawings in accordance with Section 01 33 00 - Contractor Submittals.

B. Shop Drawings: Shop drawings shall include but are not limited to the following.

1. The design of this section shall comply with Section 46 01 00 - Equipment General Provisions.

2. Dimensional drawings showing compliance with the requirements of these specifications including tolerances, non-metallic materials, and adhesives.

3. Storage and handling instructions.

C. Tolerances: Tolerances and clearances shall be as shown or specified herein. Machine work shall in all cases be of high-grade workmanship and finish, with due consideration to the special nature or function of the parts.

PART 2 -- PRODUCTS

2.1 GENERAL DESCRIPTION

A. Dewatering Screen Panel

1. Construction: Dewatering Screen shall be an all welded construction fabricated from ASTM A-276, Type 304 stainless steel. The screen surface shall be of smooth bar of a tapered wedge wire shape with inwardly enlarging openings to minimize the likelihood of debris entrapment. Screen wires shall be oriented at the specified tilt angle and shall be continuous over the length or width of each panel assembly as specified herein.

2. The dewatering fish screen panel shall be 1’-6” wide and be able to pass 2 CFS through the screen. Looped wire construction is not acceptable. Screen wires shall be welded or mechanically retained to stainless steel support bars to form a panel.

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3. Fish Screen panel shall be welded to stainless steel support bars and backing bars sufficient to withstand the specified loading conditions within the specified tolerances. The wires, support bars, backing bars, and frame members shall be welded to form a single Dewatering Screen panel assembly unit as shown on the drawings. Welds shall be smooth, without burrs or irregularities.

4. Dewatering Screen frame shall be fabricated of ASTM A-276,Type 304 stainless steel and shall be designed to the tolerances shown and specified.

5. Screen Manufacturers, or Equal

   a. Johnson Screens

   b. Hendrick Screen Company

B. Support Frame

1. **Construction:** Support frames shall be an all welded construction fabricated from ASTM A-276,Type 304 stainless steel and shall be designed to and the loads specified. The surface shall be of smooth, continuous bent steel plate to the shape indicated. The support frame shall contain water and splash and discharge it into the chamber below the assembly.

2. The support frame shall have welded steel support gusset plates and frame members sufficient to withstand the specified loading conditions within the specified tolerances. After fabrication, the support frame and dewatering screen panel shall be welded or fastened together to form a single assembly unit as shown on the drawings. Welds shall be smooth, without burrs or irregularities.

C. Assembly:

1. Provide the screen panel and support frame fully assembled and with all components necessary for installation and attachment to the support structure below.

D. DESIGN CHARACTERISTICS

1. The CONTRACTOR shall design the Dewatering Screens in accordance with the following criteria:

a.	Screen Slot Size	0.0394” (1 mm)
b.	Screen Wire Width	0.059” (1.5 mm)
c.	Screen Tilt Angle	5 degrees
d.	Maximum Gap Tolerance	1/4 inch
e.	Minimum Open Area	40%
f.	Maximum Allowable Stress	60% of Yield

2. Loading: Dewatering Screens shall be designed for lifting by the lifting holes in the bolt plates (locations to be determined by manufacturer) and for in-place loading assuming only support from the frames and backing angles.

3. Design Loads

   a. Working Loads: 62 psf (1.0 ft. hydraulic differential).

4. Panel Design Criteria – Dewatering Screens

   a. Maximum panel deflection under working loads shall not exceed 1/4-inch from the surface plane when unloaded.

   b. Maximum allowable stress (Section 2.1.D.6) shall not be exceeded in any member under ultimate loads.

   c. All welds shall be in accordance with AWS guidelines and shall be sufficient to develop the full strength of the joining members under the loadings specified.

5. The front face of the Dewatering Screen panel assembly to the finish face of the adjacent surface shall be 1/16 inch plus or minus to the dimension shown.

E. **Tolerances**: The CONTRACTOR shall design and fabricate the Dewatering Screen panels so as to ensure that the completed assembled panels are within the tolerances specified below while under a no load conditions in the installed orientation.

1. The dewatering screen panel surface shall be flat to within 1/8 inch plus or minus when measured using a 1-foot straightedge at any location or orientation on the screen face.

2. The diagonal dimensions of the dewatering screen panel shall be within 1/8 inch.

3. The front face of the installed panels to the finish surface of the adjacent support column or wall shall be 1/16 inch plus or minus.

4. Panel width shall be within 1/16 inch plus or minus.

5. The maximum gap between a panel assembly, and the bottom of the structure, the guide rails, and an adjacent panel (as installed above or below), is 0.0689-inches (1.75 mm).

6. Exposed surfaces shall be smooth to the touch.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. General: Prior to initial installation the panel assembly shall be completely assembled and dimensions verified. If the panel assembly does not fit properly corrective measures shall be taken by the contractor to adjust, trim, or reset the frame or mounting surfaces.

B. Installation Procedures

1. If the panel assembly does not fit properly, corrective measures shall be taken by the CONTRACTOR to adjust, trim, or reset the panels.

C. To ensure proper cleaning of the dewatering screen and maintaining the positive barrier to small fish, maintaining a smooth, flat, and uniform surface is critical. The Contractor shall coordinate work such that specified tolerances are achieved or bettered. Loose shims will not be allowed. Shimming to obtain surface tolerances shall be done by replacement of wear bars, permanent metal shims of the same material as the frame, fully welded to the frame, or other approved methods. Final adjustments shall not compromise the fish tightness (gap allowance), or future removal or installation of the panels.

END OF SECTION

SECTION 06 10 99 - STOPLOGS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. This section specifies the supply and installation of stoplogs for water-control structures. Stoplogs shall be provided for each pair of guides shown whether stoplogs are shown in the guides on the drawings or not.

B. The Contractor shall calculate the quantity and length of stoplogs required from the dimensions and elevations on the Drawings. Unless otherwise noted provide stoplogs to fill the full height of each guide.

C. The nominal width and thickness is as shown on the Drawings. If not indicated, board width shall be based on the nominal width of the guide less 1 inch and the thickness shall be based on the nominal guide width inside the stoplog guide.

PART 2 - MATERIALS

2.1 STOP LOGS

A. Stoplogs shall be double tongue and groove, S2S, Doug-Fir#2 and better, and shall not be pressure treated. Stoplogs actual height shall be 5-1/2" unless otherwise specified.

1. As provided by Disdero Lumber Products – Mill Grade Doug-Fir Select Deck EV1S Double Tongue and Groove:

   a. Size 3"x6" (actual 2.5"x5.5") Pattern 305-A

   b. Size 4"x6" (actual 3.5"x5.5") Pattern 405-A

2. Or Equal.

B. Stoplog wedges to secure submerged boards shall be provided for each location. Four wedges shall be provided at each location.

C. Identification and Requirements:

Stop Log Identification	Nominal Length (Guide Slots not Included)	Nominal Height	Number of Stoplogs
3-SL-1	6-feet	6-inches	2
3-SL-2	4-feet	6-inches	3
3-SL-3	3.5-feet	6-inches	4
3-SL-4	3.5-feet	6-inches	4
3-SL-5	3.5-feet	6-inches	4

PART 3 - INSTALLATION

3.1 INSTALLATION

A. Install at locations where shown on the Drawings to the height indicated.

B. Excess boards for locations where not shown to be installed to the top of the guide or not shown to be installed shall be bound and marked to indicate their location. Furnish extra boards on a pallet to the Owner as spare parts with an itemized listing of items provided.

END OF SECTION

SECTION 07 92 13 – SEALANTS AND CAULKING

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide sealants and caulking and appurtenant WORK, complete and in place in accordance with the Contract Documents.

B. The CONTRACTOR shall coordinate color samples with other Sections through the submittal process, as required by the ENGINEER.

1.2 REFERENCES

A. Where reference is made to any of the below, the revision in effect at the time of bid opening shall apply.

B. American Society for Testing and Materials (ASTM):

ASTM C 920	Elastomeric Joint Sealants
ASTM D 1752	Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction

C. Sealant, Waterproofing, and Restoration Institute (SWRI).

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Contractor Submittals.

B. Literature: Manufacturer's specifications, technical data, installation methods, and maintenance instructions, and the following:

1. Joint width and depth tables.

2. Manufacturer's full range color charts, indicating custom color availability, for color selection by OWNER.

C. Warranty: Submit a copy of the warranty.

D. Certifications:

1. Certification of Manufacturer qualifications demonstrating compliance with the qualification requirements indicated.

2. Certification of installer qualifications demonstrating compliance with the qualification requirements indicated. Include a list of 5 similar completed projects with addresses of the project location, date of project completion, and contact information of the consultant firm of record, general contractor, and owner.

3. Certification by the Manufacturer's technical field representative that surfaces have been prepared and the products have been applied in accordance with the Manufacturer's recommendations.

4. Certification from an independent testing laboratory that the submitted materials meet the requirements of the references indicated.

5. When requested by the ENGINEER, furnish other certifications as may be required to demonstrate compliance with the Contract Documents.

E. Application Schedule: Furnish a detailed and complete application schedule indicating location and detail of installation.

F. Samples: When requested by the ENGINEER, submit samples of the materials proposed. Samples shall be clearly marked to show the Manufacturer's name, product identification, finish and color. New samples shall be resubmitted of each, as required, until approved by the ENGINEER. Upon approval, the samples shall become the standard for acceptance for the project with regard to color, finish, and quality of each item. Approval of samples shall not relieve the CONTRACTOR from compliance with the Contract Documents.

1.4 QUALITY ASSURANCE

A. Single Source Responsibility: Sealants and Caulking shall be provided by a single Manufacturer, each.

B. Manufacturer Qualifications:

1. Sealants and caulking Manufacturer shall have a minimum of 20 years of sealants and caulking manufacturing experience.

2. Manufacturers without these qualifications will not be accepted.

C. Installer Qualifications:

1. Installer shall have a minimum of 5 years' experience in the successful completion of at least 5 projects of similar size and scope, employing similar products, materials, applications, and performance requirements.

2. Installers without these qualifications will not be accepted.

D. Manufacturer's Technical Field Representative: The CONTRACTOR shall arrange for a Manufacturer's technical field representative to be on Site for at least 1 day, beginning at the start of surface preparation and continuing through application, to train the installers and to supervise the WORK. The Manufacturer's technical field representative shall observe as necessary to certify in writing that the completed WORK has been performed according to the Manufacturer's instructions.

E. Sealant and caulking WORK shall comply with the following references:

1. SWRI.

2. ASTM C 920.

1.5 SPECIAL WARRANTY PROVISIONS

A. Furnish Manufacturer's 5-year written warranty to cover defects in materials, products, and manufacturing workmanship.

B. The CONTRACTOR shall furnish separate, but concurrently running, 5-year written warranty to cover labor.

C. Warranties shall be non-prorated for the entire warranty period.

D. The term of the warranties shall begin on the date of Substantial Completion.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Sealant and caulking, including compressible filler and joint backing, shall be recommended by the Manufacturer for the installation indicated.

B. Sealant and caulking, including compressible filler and joint backing, shall be suitable for, and compatible with, the required installation.

C. Sealant and caulking, including compressible filler and joint backing, shall be suitable for, and compatible with, the substrates and surfaces indicated.

D. Colors for sealants and caulking above grade and exposed to view shall be selected by the OWNER from Manufacturer's full color range, including custom colors.

2.2 INTERIOR AND EXTERIOR SEALANTS (HORIZONTAL OR SLOPED PLANES)

A. Manufacturer and Product, or Approved Equal:

1. Subject to the requirements indicated, provide Manufacturer and product listed below, or equal:

a. **Sonneborn**, a Division of **BASF; Sonolastic SL2**, including primer as recommended by Manufacturer.

B. Description: Two part, pour grade polyurethane base, ASTM C 920, Type M, Grade P, Class 25, Use T, NT, M, A, and I.

2.3 INTERIOR AND EXTERIOR SEALANTS (VERTICAL PLANE)

A. Manufacturer and Product, or Approved Equal:

1. Subject to the requirements indicated, provide Manufacturer and product listed below, or approved equal:

a. **Sonneborn,** a Division of **BASF; Sonolastic NP2**, including primer as recommended by Manufacturer.

B. Description: Multi-component, gun grade, polyurethane ASTM C 920, Type M, Grade NS Class 25, Use NT, T, M, A, G, and O.

2.4 COMPRESSIBLE FILLER

A. Manufacturer and Product, or Approved Equal:

1. Subject to the requirements indicated, provide Manufacturer and product listed below, or approved equal:

a. Sandell Manufacturing Co., Inc., Polyseal.

B. Description:

1. Compressible filler shall be an impregnated preformed compressible sealant, produced by combining permanently elastic, high density open cell, polyurethane foam with stabilizing acrylics. Compressible filler shall be supplied pre-compressed in a tape form with a PSA on one side.

2. Compressible filler shall be compatible with sealant Manufacturer's product and shall not stain the sealant nor the materials to which applied.

2.5 JOINT BACKING (BACKER ROD)

A. Description:

1. Joint backing for joints in superstructure shall be approved, resilient, closed cell polyethylene rods of diameters to suit joint conditions. Joint backing shall comply with ASTM D 1752, Type II or III.

2. Where joint depth will not allow for a rod and still provide 3/8-inch (9.5 mm) minimum depth of sealant, provide approved bond breaker tape at the bottom of the joint.

3. Joint backing shall be compatible with sealant Manufacturer's product and shall not stain the sealant nor the materials to which applied.

PART 3 -- EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in Manufacturer's original, unopened packages, containers, or bundles with labels intact, which clearly identify contents.

B. Store materials carefully in accordance with the Manufacturer's written instructions, in an area that is protected from deleterious elements, and in a manner that will prevent damage to the products.

C. Handle materials in strict accordance with Manufacturer's written instructions.

3.2 APPLICATION SCHEDULE

A. Joints noted as "caulk," "caulking," or "sealant" shall be caulked as specified herein.

B. Sealants and caulking shall be provided where external water could seep into joints damaging the substrate during freeze / thaw cycling, and other joints and penetrations indicated or required for the completion of the WORK.

C. Sealants and caulking shall also be installed elsewhere, where indicated on the Contract Drawings.

3.3 PROJECT CONDITIONS

A. Comply with Manufacturer's written instructions, and referenced standards, for environmental conditions before, during, and after installation.

B. Protect surrounding WORK from damage that may result from operations under this Section.

3.4 INSPECTION

A. The CONTRACTOR shall be totally responsible for the proper performance and completion of the WORK under this Section.

B. Systems and components shall be inspected before installation.

1. Damaged or defective items shall be rejected and marked as such and shall be removed from the Site.

C. The CONTRACTOR shall verify dimensions, tolerances, and method of attachment with adjacent WORK.

1. Examine substrates, areas, and conditions where sealants and caulking will be installed for compliance with the requirements for installation, taking into account tolerances, and other conditions affecting performance of installed sealants and caulking.

a. Surfaces to receive sealants and caulking, including compressible filler and joint backing, shall be dry, free of oil, dirt, dust and other contaminants and loose materials, and shall be in the proper condition as indicated by the Manufacturer prior to the application of the sealant and caulking materials.

b. Concrete and cementitious products shall have been completely cured and the surface shall be dry and free from frost at the time of application.

c. Joint shapes and sizes shall be as indicated. Where not indicated, joint shapes and sizes shall be as necessary for job conditions, as directed by the ENGINEER.

2. Notify the 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 in an acceptable manner.

3. Commencement of the installation by the CONTRACTOR shall indicate CONTRACTOR's acceptance of the substrate, areas, and conditions.

3.5 SURFACE PREPARATION

A. Surface preparation shall be in compliance with the applicable references and with the Manufacturer's written instructions.

B. Coatings, including curing compounds, form release agents, and other substances shall be removed as recommended by the sealant and caulking Manufacturer.

C. Protrusions, bumps, ridges, and loose substrate surface materials shall be removed by sanding or grinding.

D. Laitance, efflorescence, and loose mortar shall be removed from the joint cavity.

E. Ferrous metal surfaces shall be cleaned of rust, mill scale, and other coatings by wire brush, grinding, or sandblasting.

F. Protective coatings shall be removed from surfaces to receive sealants and caulking.

1. Solvents used to remove protective coating shall be as recommended by the sealant and caulking Manufacturer, shall be compatible with the adjacent materials and surfaces, shall not damage adjacent finishes, and shall be non-staining.

G. Bituminous or resinous materials shall be removed from surfaces to receive sealants and caulking.

H. Immediately before application of sealant and caulking materials, scrape surfaces to be covered free from foreign materials and brush clean.

I. Substrate shall be swept to remove all loose materials prior to beginning sealant and caulking installation.

3.6 PREPARATION

A. Sequence installation properly with the installation and protection of other WORK, so that neither will be damaged by the installation of the other.

3.7 INSTALLATION

A. Installation shall comply with the requirements of the Contract Documents, with applicable references, and with Manufacturer’s written instructions. Where a conflict occurs among these requirements, the more stringent shall apply, as directed by the ENGINEER.

B. Primer, if recommended by the Manufacturer for the application, shall be applied per the Manufacturer's recommended procedures.

1. Primer shall be used on concrete masonry units, wood, or other porous surfaces in accordance with instructions furnished with the sealant. Primer shall be applied to the joint surfaces to be sealed. Surfaces adjacent to joints shall not be primed.

C. Multi-component sealants shall be mixed according to Manufacturer’s printed instructions. Sealant in guns shall be applied with a nozzle of proper size to fit the width of joint. Sealant shall be installed to the required depth without displacing the backing. Unless otherwise indicated or recommended by the Manufacturer, the installed sealant shall be tooled so that the surface is uniformly smooth and free of wrinkles and to assure full adhesion to the sides of the joint. Sealants shall be installed free of air pockets, foreign embedded matter, ridges, and sags. Sealer shall be applied over the sealant if recommended by the sealant Manufacturer.

D. Sealant depth in joints shall be half of the width of joint, but not less than 1/8-inch (3.2 mm) deep and 1/4-inch (6.4 mm) wide nor more than 1/2-inch (12.7 mm) deep and one-inch wide (25.4 mm). For joints greater than 1-inch (25.4 mm) wide, provide sealant in a 2 to 1 width-to-depth ratio.

E. Joints shall have a rigid filler material installed to proper depth prior to application of sealant.

F. Masking film shall be placed on the finish surface on one or both sides of a joint cavity to protect adjacent finish surfaces from primer or sealant smears. Masking shall be removed as soon as possible after joint has been filled and tooled.

G. Backing shall be installed to provide the indicated sealant depth. The installation tool shall be shaped to avoid puncturing the backing.

H. Bond-breaker shall be applied to fully cover the bottom of the joint without contaminating the sides where sealant adhesion is required.

I. A full bead of sealant shall be applied into the joint under sufficient pressure, with the nozzle drawn across sealant, to completely fill the void space and to ensure complete wetting of contact area to obtain uniform adhesion. During application, the tip of the nozzle shall be kept at the bottom of the joint thereby forcing the sealant to fill from the bottom to the top. Sealants shall be tooled immediately after exposure with a caulking tool or soft bristled brush moistened with solvent. The finished sealant-filled joint shall be slightly concave unless otherwise indicated.

3.8 CLEANING, FINISHING, AND PROTECTION

A. Adhesive papers used for masking which become firmly bonded when exposed to heat and/or light shall not be used.

1. Remove masking film and temporary labels as soon as possible after installation. Films and labels left in place after installation shall be the responsibility of the CONTRACTOR.

2. Residue shall not be left on any surfaces.

3. The surfaces of materials adjoining caulked joints shall be cleaned free of smears of sealant or other soiling due to caulking operations.

B. Sealants and caulking shall be protected from damage from subsequent construction operations.

C. The CONTRACTOR shall make adjustments required until accepted.

D. Damaged or defective items shall be removed and replaced as directed by ENGINEER.

E. When sealant and caulking WORK is completed, remove unused materials, containers, and equipment, and clean the Site of sealant and caulking debris.

END OF SECTION

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SECTION 09 96 00 - PROTECTIVE COATINGS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide protective coatings, complete and in place, in accordance with the Contract Documents.

B. Definitions

1. The term "paint," "coatings," or "finishes" as used herein, shall include surface treatments, emulsions, enamels, paints, epoxy resins, and other protective coatings, excepting galvanizing or anodizing, whether used as a pretreatment, primer, intermediate coat, or finish coat.

2. The term "DFT" means minimum dry film thickness, without any negative tolerance.

C. The following surfaces shall not be coated:

1. Concrete, unless required by items on the concrete coating schedule below or the Drawings.

2. Stainless steel

3. Machined surfaces

4. Grease fittings.

5. Glass

6. Equipment nameplates

7. Platform gratings, stair treads, door thresholds, and other walk surfaces, unless specifically indicated to be coated.

8. Platform gratings, stair treads, door thresholds, and other walk surfaces, unless specifically indicated to be coated.

D. The coating system schedules summarize the surfaces to be coated, the required surface preparation, and the coating systems to be applied. Coating notes on the Drawings are used to show or extend the limits of coating schedules, to show exceptions to the schedules, or to clarify or show details for application of the coating systems.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals.

B. Submittals shall include the following information and be submitted at least 30 Days prior to commencing protective coating WORK:

1. Materials List: Eight copies of a coating materials list showing the manufacturer and the product number, keyed to the coating systems herein. The list shall be submitted prior to or at the time of submitting samples.

2. Manufacturer's Information: For each coating system to be used, the following data:

   a. Manufacturer's data sheet for each product proposed, including statements on the suitability of the material for the intended use.

   b. Technical and performance information that demonstrates compliance with the system performance and material requirements.

   c. Paint manufacturer's instructions and recommendations on surface preparation and application.

   d. Colors available for each product (where applicable).

   e. Compatibility of shop and field applied coatings (where applicable).

   f. Material Safety Data Sheet for each product proposed.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Suitability: The CONTRACTOR shall use suitable coating materials as recommended by the manufacturer. Materials shall comply with Volatile Organic Compound (VOC) limits applicable at the Site.

B. Material Sources: Where manufacturers and product numbers are listed, it is to show the type and quality of coatings that are required. If a named product does not comply with VOC limits in effect at the time of Bid opening, that product will not be accepted, and the CONTRACTOR shall propose a substitution product of equal quality that does comply. Proposed substitute materials will be considered as indicated below. Coating materials shall be materials that have a record of satisfactory performance in industrial plants, manufacturing facilities, and water and wastewater treatment plants.

C. Compatibility: In any coating system only compatible materials from a single manufacturer shall be used in the WORK. Particular attention shall be directed to compatibility of primers and finish coats. If necessary, a barrier coat shall be applied between existing prime coat and subsequent field coats to ensure compatibility.

D. Containers: Coating materials shall be sealed in containers that plainly show the designated name, formula or specification number, batch number, color, date of manufacture, and name of manufacturer, all of which shall be plainly legible at the time of use.

E. Colors: Colors and shades of colors of coatings shall be as indicated or selected by the ENGINEER. Each coat shall be of a slightly different shade to facilitate inspection of surface coverage of each coat. Finish colors shall be as selected from the manufacturer's standard color samples by the ENGINEER.

F. Substitute or "Or-Equal" Products

   1. To establish equality under Section 01 25 00 – Substitution Procedures, the CONTRACTOR shall furnish satisfactory documentation from the manufacturer of the proposed substitute or "or-equal" product that the material meets the indicated requirements and is equivalent or better in the following properties:

      a. Minimum and maximum recoat times

b. Minimum and maximum cure time for immersion

c. Abrasion resistance per ASTM D4060 using CS17 Wheel

d. Maximum and minimum dry film thickness per coat

e. Compatibility with other coatings

f. Suitability for the intended service

g. Resistance to chemical attack

h. Temperature limitations during application and in service

i. Type and quality of recommended undercoats and topcoats

j. Ease of application

k. Ease of repairing damaged areas

l. Stability of colors

2. Protective coating materials shall be standard products produced by recognized manufacturers who are regularly engaged in production of such materials for essentially identical service conditions. When requested, the CONTRACTOR shall provide the ENGINEER with the names of not less than 10 successful applications of the proposed manufacturer's products that comply with these requirements.

3. If a proposed substitution requires changes in the WORK, the CONTRACTOR shall bear such costs involved as part of the WORK.

2.2 INDUSTRIAL COATING SYSTEMS

A. System 5 - Inorganic Zinc/Epoxy/Polyurethane

1. Materials

Prime Coat	Inorganic zinc silicate, water-based, 2 component
Zinc content in dry film	79 percent, minimum
VOC content, max (g/L)	0
Demonstrated suitable for	Ferrous metal, providing superior corrosion, chemical, and abrasion resistance, recommended for use as primer under epoxy
Intermediate Coat	2 component epoxy, high build, recommended by manufacturer for application over inorganic zinc primer
Demonstrated suitable for	Outstanding chemical, corrosion, and abrasion resistance
VOC content, max (g/L)	100
Finish Coat	2 component aliphatic or acrylic polyurethane
Demonstrated suitable for	Superior color and gloss retention, resistance to chemical fumes, severe weathering, and abrasion
VOC content, max (g/L)	100

2. Application and manufacturers

Surface preparation for primer		SSPC SP 10	
Anchor profile for primer		per manufacturer	
Prime Coat (DFT = 3 - 4 mils)	**Intermediate Coat (DFT = 4 - 6 mils)**	**Finish Coat (DFT = 3 - 4 mils)**	**Total System DFT**
PPG- Dimetcote 21-5	PPG Amerlock 2/400 VOC	Amershield VOC	10 - 14 mils
Carboline Carbozinc 11WB	Carboline Carboguard 890 VOC	Carboline Carbothane 134 MC	
Tnemec Tneme-Zinc 94H20	Tnemec Series L69	Tnemec Endura-Shield Series 1094 for Gloss finish (use Series 1095 for Semi-Gloss finish)	
Sherwin Williams Zinc Clad III HS 100	S W Macropoxy 646-100	S W WB Acrolon 100	

2.3 SUBMERGED AND SEVERE SERVICE COATING SYSTEMS

A. System 100 - Amine Cured Epoxy

1. Material

Type	high build, amine cure epoxy
VOC content, g/L max	100
Demonstrated suitable for	steel, long term immersion in water and wastewater, resistant to corrosion, chemical fumes, good color retention

2. Application and manufacturers

Products (3 coats or more)	**Total System DFT**
PPG Novaguard 840	15 to 17 mils For non-submerged valves and other equipment, DFT = 10 to 12 mils
Carboline Carboguard 891 VOC	
Sherwin Williams Tank Clad HS	
Sherwin Williams Macropoxy 646 PW	

A. System 102 - Polyamide Epoxy

1. Materials

Type	high build polyamide cure epoxy
VOC content, max (g/L)	100
Demonstrated suitable for	long term immersion in water resistant to corrosion and chemical fumes, good color retention
Certification	NSF 61 if in contact with potable water

2. Application and manufacturers

Products (3 coats or more)	**Total System DFT**
Tnemec Series 22 Epoxoline	12-18 mils
PPG- Amerlock 2/400 VOC	
Carboline - Carboguard 891 VOC	
Sherwin Williams Macropoxy 646 PW	

B. System 106 - Fusion Bonded Epoxy

1. Material

Type	100 percent solids fusion bond epoxy
Demonstrated suitable for	fluidized bed or electrostatic spray application, recommended for pumps, valves, pipe appurtenances, tanks, pipe hangers, flow meters, and hydrants
Certification requirement	NSF 61

2. Application in accordance with AWWA C213 and the following:

Product	Surface and DFT
3M Scotchkote 134 or 206N	Valves 12-mils
	All others 16-mils

2.4 SPECIAL COATING SYSTEMS

A. **System 205 - Polyethylene Encasement:** Application of polyethylene encasement shall be in accordance with ANSI/AWWA C105 using Method C.

B. System 208 - Aluminum Metal Isolation

1. Material

Type	high build polyamide epoxy with chemical and abrasion resistance

Demonstrated suitable for	concrete and aluminum substrates, to isolate aluminum from contact with concrete and the resulting chemical degradation
VOC content, max (g/L)	100

2. Application and manufacturers

Coating (DFT = 16 - 20 mils)
Amerlock 2/400 VOC
Sherwin Williams Macropoxy 646-100
Tnemec Epoxoline Series L69
Carboline - Carboguard 890 VOC

PART 3 -- EXECUTION

3.1 MANUFACTURER'S SERVICES

A. The CONTRACTOR shall require the protective coating manufacturer to furnish a qualified technical representative to visit the Site for technical support as may be necessary to resolve field problems.

3.2 WORKMANSHIP

A. Skilled craftsmen and experienced supervision shall be used on coating WORK.

B. Coating shall be done in a workmanlike manner so as to produce an even film of uniform thickness. Edges, corners, crevices, and joints shall receive special attention to insure thorough surface preparation. The finished surfaces shall be free from runs, drops, ridges, waves, laps, brush marks, and variations in color, texture, and finish. The hiding shall be so complete that the addition of another coat would not increase the hiding. Special attention shall be given so that edges, corners, crevices, welds, and similar areas receive a film thickness equivalent to adjacent areas, and installations shall be protected by the use of drop cloths or other precautionary measures.

C. Damage to other surfaces resulting from the WORK shall be cleaned, repaired, and refinished to original condition.

3.3 STORAGE, MIXING, AND THINNING OF MATERIALS

A. Manufacturer's Recommendations**:** Unless otherwise indicated, the coating manufacturer's printed recommendations and instructions for thinning, mixing, handling, applying, and protecting its coating materials, for preparation of surfaces for coating, and for other procedures relative to coating shall be strictly observed.

B. Coating materials shall be used within the manufacturer's recommended shelf life.

C. Storage and Mixing: Coating materials shall be stored under the conditions recommended by the Product Data Sheets, and shall be thoroughly stirred, strained, and kept at a uniform consistency during application. Coatings from different manufacturers shall not be mixed together.

3.4 PREPARATION FOR COATING

A. General: Surfaces to receive protective coatings shall be prepared as indicated prior to application of coatings. The CONTRACTOR shall examine surfaces to be coated and shall correct surface defects before application of any coating material. Marred or abraded spots on shop-primed and on factory-finished surfaces shall receive touch-up restoration prior to any field coating application. Surfaces to be coated shall be dry and free of visible dust.

B. Protection of Surfaces Not to be Coated: Surfaces that are not to receive protective coatings shall be protected during surface preparation, cleaning, and coating operations.

C. Hardware, lighting fixtures, switch plates, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not to be painted shall be removed, masked, or otherwise protected. Drop cloths shall be provided to prevent coating materials from falling on or marring adjacent surfaces. The working parts of mechanical and electrical equipment shall be protected from damage during surface preparation and coating operations. Openings in motors shall be masked to prevent entry of coating or other materials.

D. Care shall be exercised not to damage adjacent WORK during blasting operations. Spraying shall be conducted under carefully controlled conditions. The CONTRACTOR shall be fully responsible for and shall promptly repair any and all damage to adjacent WORK or adjoining property occurring from blasting or coating operations.

E. Protection of Painted Surfaces: Cleaning and coating shall be coordinated so that dust and other contaminants from the preparation process will not fall on wet, newly-coated surfaces.

3.5 ENVIRONMENTAL REQUIREMENTS

A. No coating work shall be performed under the following conditions:

1. Surface or ambient temperatures exceed the manufacturer's recommended maximum or minimum allowable.

2. Dust or smoke laden atmosphere.

3. Damp or humid conditions, where the relative humidity is above the manufacturer's maximum allowable.

4. Substrate and ambient temperatures are less than 5°F above the dew point and are decreasing. Dew point shall be measured by use of an instrument such as a Sling Psychrometer in conjunction with U.S. Department of Commerce, Weather Bureau psychrometric tables. Elcometer 319 Dew Point meter or equal may also be used.

5. Ambient temperature that is expected to drop below 50°F or less than 5°F above the dew point within 8 hours after application of coating.

3.6 SURFACE PREPARATION STANDARDS

A. The following referenced surface preparation specifications of the Steel Structures Painting Council shall form a part of this specification:

1. Solvent Cleaning (SSPC SP 1): Removal of oil, grease, soil, salts, and other soluble contaminants by cleaning with solvent, vapor, alkali, emulsion, or steam.

2. Hand Tool Cleaning (SSPC SP 2): Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, by hand chipping, scraping, sanding, and wire brushing.

3. Power Tool Cleaning (SSPC SP 3): Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, by power tool chipping, descaling, sanding, wire brushing, and grinding.

4. White Metal Blast Cleaning (SSPC SP 5/NACE 1): Removal of all visible rust, oil, grease, soil, dust, mill scale, paint, oxides, corrosion products and foreign matter by blast cleaning.

5. Commercial Blast Cleaning (SSPC SP 6/NACE 3): Removal of all visible oil, grease, soil, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter, except that staining shall be limited to no more than 33 percent of each square inch of surface area.

6. Brush-Off Blast Cleaning (SSPC SP 7/NACE 4): Removal of all visible oil, grease, soil, dust, loose mill scale, loose rust, and loose paint.

7. Near-White Blast Cleaning (SSPC SP 10/NACE 2): Removal of all visible oil, grease, soil, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter, except that staining shall be limited to no more than 5 percent of each square inch of surface area.

8. Power Tool Cleaning to Bare Metal (SSPC 11) When viewed without magnification, the surface shall be free of all visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter. Slight residues of rust and paint may be left in the lower portion of pits if the original surface is pitted. The surface profile shall not be less than 1 mil (25 microns).

9. Surface Preparation of Concrete (SSPC-SP 13/NACE 6): Removal of protrusions, laitance and efflorescence, existing coatings, form-release agents, and surface contamination by detergent or steam cleaning, abrasive blasting, water jetting, or impact or power tool methods as appropriate for the condition of the surface and the requirements of the coating system.

3.7 FERROUS METAL SURFACE PREPARATION (UNGALVANIZED)

A. The minimum abrasive blasting surface preparation shall be as indicated in the coating system schedules included at the end of this Section. Where there is a conflict between these requirements and the coating manufacturer's printed recommendations for the intended service, the higher degree of cleaning shall apply.

B. The Shop Painting Facility shall use a minimum blast material mixture of 75% grit and 25% shot material to achieve the proper surface profile.

C. The Field Coating Applicator shall abrasive blast the shop coated surfaces per SSPC SP 7/NACE 4. The previously shop-painted surfaces shall be abraded prior to the application of the final coats. Special attention shall be given to uncoated steel weld joints, coating holdbacks, and bare metal.

D. Grease, oil, and welding fluxes shall be removed by wiping with MEK or naphtha cleaning or with trisodium phosphate detergent per SSPC SP 1.

E. All sharp edges shall be rounded or chamfered and all burrs, rust, scale, welding slag, and spatter shall be removed and the surface prepared by SSPC SP 2 hand tool cleaning, and SSPC SP 3 power tool cleaning.

F. The Contractor shall test the surfaces for soluble salts with the use of Chlor*Test as manufactured by Chlor*Rid International or approved equivalent. Any blasted surfaces shall be tested and shall have a maximum concentration of 5 micrograms per square centimeter ($\mu g/cm^2$). A test shall be conducted for every 100 square feet (ft2) of surface area to be coated at locations determined by the Inspector.

G. If the soluble salt test indicates chloride concentrations greater than those outlined in these Specifications, the Contractor shall use Chlor*Rid, as manufactured by Chlor*Rid International, in the water source during Water Cleaning to remove the salts from the substrate. A substrate's surface preparation will be accepted once the soluble salt concentration is below the amounts outlined in these Specifications.

H. The type and size of abrasive shall be selected to produce a surface profile that meets the coating manufacturer's recommendation for the particular coating and service conditions. Abrasive shall not be reused unless an automated blasting system is used for surfaces that will be in non-submerged service. For automated blasting systems, clean oil-free abrasives shall be maintained. The abrasive mix shall include at least 50 percent grit.

I. The CONTRACTOR shall comply with the applicable federal, state, and local air pollution control regulations for blast cleaning.

J. Compressed air for air blast cleaning shall be supplied at adequate pressure from well-maintained compressors equipped with oil and moisture separators that remove at least 95 percent of the contaminants.

K. Surfaces shall be cleaned of dust and residual particles of the cleaning operation by dry air blast cleaning, vacuuming, or another approved method prior to painting.

L. Enclosed areas and other areas where dust settling is a problem shall be vacuum-cleaned and wiped with a tack cloth.

M. Damaged or defective coating shall be removed by the blast cleaning to meet the clean surface requirements before recoating.

N. If the required abrasive blast cleaning will damage adjacent WORK, the area to be cleaned is less than 100 square feet, and the coated surface will not be submerged in service, then SSPC SP 2 or SSPC SP 3 may be used.

O. Shop-applied coatings of unknown composition shall be completely removed before the indicated coatings are applied. Valves, castings, ductile or cast iron pipe, and fabricated pipe or equipment shall be examined for the presence of shop-applied temporary coatings. Temporary coatings shall be completely removed by solvent cleaning per SSPC SP 1 before the abrasive blast cleaning has been started.

P. Shop primed equipment shall be solvent-cleaned in the field before finish coats are applied.

3.8 FERROUS METAL SURFACE PREPARATION (GALVANIZED)

A. Galvanized ferrous metal shall be alkaline cleaned per SSPC SP 1 to remove oil, grease, and other contaminants detrimental to adhesion of the protective coating system, followed by brush off blast cleaning per SSPC SP 7/NACE 4.

B. Any high spots, sharp protrusions, and rough edges, such as the metal drip line, shall be smoothed to avoid paint film gaps in the areas of the high spots. Surfaces shall be hand tool cleaned per SSPC SP 2 and power tool cleaned per SSPC SP 3.

C. Pretreatment coatings of surfaces shall be in accordance with the printed recommendations of the coating manufacturer. Galvanized metals may be cleaned with suitable organic solvent such as a rust inhibitor or aqueous alkaline solution per ASTM D6386.

D. The surfaces of galvanized steel exposed to chemical splashing or within a wastewater head space shall be abraded per SSPC SP 11 or SP 7 prior to coating.

3.9 SURFACE PREPARATION OF FERROUS SURFACES WITH EXISTING COATINGS, EXCLUDING STEEL RESERVOIR INTERIORS

A. General: Grease, oil, heavy chalk, dirt, or other contaminants shall be removed by solvent or detergent cleaning prior to abrasive blast cleaning. The generic type of the existing coatings shall be determined by laboratory testing.

B. Abrasive Blast Cleaning: The CONTRACTOR shall provide the degree of cleaning indicated in the coating system schedule for the entire surface to be coated. If the degree of cleaning is not indicated in the schedule, deteriorated coatings shall be removed by abrasive blast cleaning to SSPC SP 6/NACE 3. Areas of tightly adhering coatings shall be cleaned to SSPC SP 7/NACE 4, with the remaining thickness of existing coating not to exceed 3-mils.

C. Incompatible Coatings: If coatings to be applied are not compatible with existing coatings the CONTRACTOR shall apply intermediate coatings per the manufacturer's recommendation for the indicated coating system or shall completely remove the existing coating prior to abrasive blast cleaning. A small trial application shall be conducted for compatibility prior to painting large areas.

D. Unknown Coatings: Coatings of unknown composition shall be completely removed prior to application of new coatings.

E. Water Abrasive or Wet Abrasive Blast Cleaning: Where indicated or where Site conditions do not permit dry abrasive blasting for industrial coating systems due to dust or air pollution considerations, water abrasive blasting or wet abrasive blasting may be used. In both methods, paint-compatible corrosion inhibitors shall be used, and coating application shall begin as soon as the surfaces are dry. Water abrasive blasting shall be done using high pressure water with sand injection. In both methods, the equipment used shall be commercially produced equipment with a successful service record. Wet blasting methods shall not be used for submerged or severe service coating systems unless indicated.

3.10 SHOP COATING REQUIREMENTS

A. Unless otherwise indicated, items of equipment or parts of equipment which are not submerged in service shall be shop-primed and then finish-coated in the field after installation with the indicated or selected color. The methods, materials, application equipment, and other details of shop painting shall comply with this Section. If the shop primer requires top coating within a specific period of time, the equipment shall be finish-coated in the shop and then be touched up after installation.

B. Items of equipment or parts and surfaces of equipment which are submerged or inside an enclosed hydraulic structure when in service, with the exception of pumps and valves, shall have surface preparation and coating performed in the field.

C. Shop primed surfaces which are to be incorporated in the work shall be prepared in the field by cleaning all surfaces as necessary in accordance with SSPC SP 1 and SP 2. Damaged shop coating shall be cleaned in accordance with SSPC SP 3, Power Tool Cleaning, and recoated with the primer specified.

D. For every 500 square feet, or less, of steel surface blasted, the surface profile shall be tested with the use of Press-o-Film as manufactured by Testex, or other RP0287 approved equal, at locations to be determined by the Inspector. The replica tape thickness shall be measured using a dial micrometer manufactured by Testex, or other ASTM D4417 Type C approved equal. For each test area, one replica tape test shall be performed. For each test area, the three replica tape thickness values shall be recorded and must be within 10% of the coating manufacturer's recommended profile. If the surface profile does not meet the manufacturer's recommended profile, two additional tests will be performed within a 12-inch diameter of the initial test. If the values are not satisfactory, the Contractor shall reblast the affected areas.

E. The interior surfaces of steel water reservoirs, except for Paragraph A surfaces, shall have surface preparation and coating WORK performed in the field.

F. For certain pieces of equipment it may be undesirable or impractical to apply finish coatings in the field. Such equipment may include engine generator sets, equipment such as electrical control panels, switchgear or main control boards, submerged parts of pumps, ferrous metal passages in valves, or other items where it is not possible to obtain the indicated quality in the field. Such equipment shall be primed and finish-coated in the shop and touched up in the field with the identical material after installation. The CONTRACTOR shall require the manufacturer of each such piece of equipment to certify as part of its Shop Drawings that the surface preparation is in accordance with these specifications. The coating material data sheet shall be submitted with the Shop Drawings for the equipment.

G. For certain small pieces of equipment the manufacturer may have a standard coating system that is suitable for the intended service conditions. In such cases, the final determination of suitability will be made during review of the Shop Drawing submittals. Equipment of this type generally includes only indoor equipment such as instruments, small compressors, and chemical metering pumps.

H. Shop-painted surfaces shall be protected during shipment and handling by suitable provisions including padding, blocking, and the use of canvas or nylon slings. Primed surfaces shall not be exposed to the weather for more than 2 months before being top coated or less time if recommended by the coating manufacturer.

I. Damage to shop-applied coatings shall be repaired in accordance with this Section and the coating manufacturer's printed instructions.

J. The CONTRACTOR shall make certain that the shop primers and field topcoats are compatible and meet the requirements of this Section. Copies of applicable coating manufacturer's data sheets shall be submitted with equipment Shop Drawings.

3.11 APPLICATION OF COATINGS

A. The application of protective coatings to steel substrates shall be in accordance with SSPC PA1 - Paint Application Specification No. 1.

B. Cleaned surfaces and each coat shall be inspected prior to applying each succeeding coat. The CONTRACTOR shall schedule such inspection with the ENGINEER in advance.

C. Blast cleaned ferrous metal surfaces shall be painted before any rusting or other deterioration of the surface occurs. Blast cleaning shall be limited to only those surfaces that can be coated in the same day.

D. Coatings shall be applied in accordance with the manufacturer's instructions and recommendations and this Section, whichever has the most stringent requirements.

E. Special attention shall be given to edges, angles, weld seams, flanges, nuts and bolts, and other places where insufficient film thicknesses are likely to be present. CONTRACTOR shall use an independent stripe coat per SSPC PA Guide 11 for these areas. Particular care shall be used to ensure that the specified coverage is secured on the edges and corners of all surfaces.

F. Special attention shall be given to materials that will be joined so closely that proper surface preparation and application are not possible. Such contact surfaces shall be coated prior to assembly or installation.

G. Finish coats, including touch-up and damage repair coats shall be applied in a manner that will present a uniform texture and color matched appearance.

H. Coatings shall not be applied under the following conditions:

1. Temperatures exceeding the manufacturer's recommended maximum and minimum allowable.

2. Concrete surfaces will be in direct sunlight during application or within 3 hours after application.

3. Dust or smoke laden atmosphere.

4. Damp or humid weather.

5. Substrate or air temperature is less than 5 degrees F above the dew point.

6. Air temperature is expected to drop below 40 degrees F or less than 5 degrees F above the dew point within 8 hours after application of coating.

7. Wind conditions are not calm.

I. Dew point shall be determined by use of a sling psychrometer in conjunction with U.S. Dept. of Commerce, Weather Bureau psychometric tables.

J. Unburied steel piping shall be abrasive blast cleaned and primed before installation.

K. Finish coats shall be applied after concrete, masonry, and equipment installation is complete, and the working areas are clean and dust free.

3.12 CURING OF COATINGS

A. The CONTRACTOR shall maintain curing conditions in accordance with the conditions recommended by the coating material manufacturer or by this Section, whichever is the most stringent, prior to placing the completed coating system into service.

B. In the case of enclosed areas, forced air ventilation, using heated air if necessary, may be required until the coatings have fully cured.

3.13 IDENTIFICATION OF PIPING

A. Identification of piping shall be in accordance with Section 40 05 02 - Piping Identification.

3.14 SHOP AND FIELD INSPECTION AND TESTING

A. General: The CONTRACTOR shall give the ENGINEER a minimum of 3 Days advance notice of the start of any field surface preparation or coating application, and a minimum of 7 Days advance notice of the start of any surface preparation activity in the shop.

B. Such WORK shall be performed only in the presence of the ENGINEER, unless the ENGINEER has granted prior approval to perform such WORK in its absence.

C. Inspection by the ENGINEER, or the waiver of inspection of any particular portion of the WORK, shall not relieve the CONTRACTOR of its responsibility to perform the WORK in accordance with these Specifications.

D. Scaffolding shall be erected and moved to locations where requested by the ENGINEER to facilitate inspection. Additional illumination shall be furnished on areas to be inspected.

E. Inspection Devices: The CONTRACTOR shall furnish inspection devices in good working condition for the detection of holidays and measurement of dry film thicknesses of coatings. Dry-film thickness gauges shall be made available for the ENGINEER's use while coating is being done, until final acceptance of such coatings. The CONTRACTOR shall furnish the services of a trained operator of the holiday detection devices until the final acceptance of such coatings. Holiday detection devices shall be operated only in the presence of the ENGINEER.

F. Holiday Testing: The CONTRACTOR shall test for continuity all coated ferrous surfaces inside a steel reservoir, other surfaces that will be submerged in water or other liquids, surfaces that are enclosed in a vapor space in such structures, and surfaces coated with any of the submerged and severe service coating systems. Areas that contain discontinuities shall be marked and repaired or recoated in accordance with the coating manufacturer's printed instructions and then be retested.

1. Coatings with thickness exceeding 20-mils total DFT: Pulse-type holiday detector such as **Tinker & Rasor Model AP-W, D.E. Stearns Co. Model 14/20,** or equal shall be used. The unit shall be adjusted to operate at the voltage required to cause a spark jump across an air gap equal to twice the required coating thickness.

2. Coatings with thickness of 20-mils or less total DFT: **Tinker & Rasor Model M1** non-destructive type holiday detector, **K-D Bird Dog,** or equal shall be used. The unit shall operate at less than 75 volts. For thicknesses between 10- and 20-mils, a non-sudsing type wetting agent, such as **Kodak Photo-Flo** or equal, shall be added to the water prior to wetting the detector sponge.

G. Film Thickness Testing: On ferrous metals, the dry film coating thickness shall be measured in accordance with the SSPC Paint Application Specification No. 2 using a magnetic type dry film thickness gauge such as **Mikrotest Model FM, Elcometer Model 111/1EZ,** or equal. Each coat shall be tested for the correct thickness. No measurements shall be made until at least 8 hours after application of the coating. On non-ferrous metals and other substrates, the coating thicknesses shall be measured at the time of application using a wet film gauge.w

H. Surface Preparation: Confirm proper surface profile with Testex Press-O-Film replica tape in accordance with NACE RP0287-02.

3.15 Coating System Schedule, Ferrous Metal - Not Galvanized

	Item	Surface Prep.	System No.
FM-1	All surfaces indoors and outdoors, exposed or covered, except those included below.	Commercial blast cleaning SSPC SP 6/NACE 3	(5) inorganic zinc/epoxy/ polyurethane
FM-8	Ferrous surfaces in water passages of all valves 2-inch size and larger, exterior surfaces of submerged valves.	White metal blast cleaning SSPC SP 5/NACE 1	(102) polyamide epoxy
FM-9	Ferrous surfaces in water passages and submerged surfaces of all pumps which have discharge size of 4 inches or larger, wall thimbles.	White metal blast cleaning SSPC SP 5/NACE 1	(100) amine cure epoxy
FM-10	Ferrous surfaces of sleeve couplings.	Solvent cleaning SSPC SP 1, followed by white metal blast cleaning SSPC-SP 10/NACE 2	(106) fusion bond epoxy
FM-11	Buried surfaces that are not indicated to be coated elsewhere.	Near white metal blast cleaning SSPC SP 10/NACE 2	(100) amine cure epoxy
FM-19	Buried pipe couplings, valves, and flanged joints (where piping is ductile or cast iron, not tape-coated), including factory-coated surfaces.	As specified by reference specification	(205) polyethylene encasement

3.16 COATING SYSTEM SCHEDULE, NON-FERROUS METAL, PLASTIC, FIBER GLASS

A. Where isolated non-ferrous parts are associated with equipment or piping, the CONTRACTOR shall use the coating system for the adjacent connected surfaces. Do not coat handrails, gratings, frames or hatches. Only primers recommended by the coating manufacturer shall be used.

	Item	Surface Prep.	System No.
NFS-3	Aluminum surfaces in contact with concrete, or with any other metal except galvanized ferrous metal.	Solvent cleaned SSPC	(208) aluminum metal isolation

END OF SECTION

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SECTION 13 34 21 - PRE-ENGINEERED METAL BUIILDINGS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide a pre-engineered metal building(s) and appurtenant WORK, complete and in place, with operational components, in accordance with the Contract Documents.

B. There are two pre-engineered buildings: the spawning shed canopy shown in Area 6 drawings and the Water Treatment Shed in the Area 11 drawings.

C. The CONTRACTOR shall furnish professional design and engineering services as required for pre-engineered metal building(s) and appurtenances as indicated herein.

1. Professional design and engineering services may be provided by the manufacturer or by an independent licensed structural engineer retained by the CONTRACTOR, either of which shall comply with the requirements indicated.

D. The CONTRACTOR shall coordinate color samples with other Sections through the submittal process.

1.2 REFERENCES

A. Where reference is made to any of the below, the revision in effect at the time of bid opening shall apply.

B. American Institute of Steel Construction (AISC)

AISC Steel Construction Manual, Sixteenth Edition

C. American Iron and Steel Institute (AISI)

AISI Specification for the Design of Cold Formed Steel Structural Members

AISI Design of Light Gage Steel Diaphragms

D. American Society for Testing and Materials (ASTM)

ASTM A 36 Specification for Carbon Structural Steel

ASTM A 307 Specification for Carbon Steel Bolts and Studs, 60,000 PSI Ultimate Tensile Strength

ASTM A 325 Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Ultimate Tensile Strength

ASTM A 529 Specification for High-Strength Carbon-Manganese Steel of Structural Quality

ASTM A 572 Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel

ASTM A 653 Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

ASTM A 992 Steel for Structural Shapes For Use In Building Framing

ASTM A 1008 Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable

ASTM A 1011 Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength

E. American Welding Society

AWS D1.1 Structural Welding Code-Steel

F. Metal Building Manufacturer's Association (MBMA)

Metal Building Systems Manual.

G. Architectural Aluminum Manufacturers Association (AAMA).

H. Building Code: Refer to the Drawings to determine which building code applies. The applicable building code, defined by the Drawings, is referenced herein as "the CODE."

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals.

B. Literature: Manufacturer's specifications, technical data, installation methods, and maintenance instructions, and the following:

1. Complete operation instructions for operable components.

2. Manufacturer's full-range color charts, indicating custom color availability for color selection by the OWNER.

3. Additional information for the building system, roof panels, accessories and components.

C. Warranty: Submit a copy of the warranty.

D. Certifications

1. Certification of compliance with the Structural Requirements of paragraph 2.1.A.

2. Certification of manufacturer qualifications demonstrating compliance with the qualifications requirements indicated. Include a list of 5 similar completed projects with addresses of the project location, date of project completion, manufacturer's

products, and contact information of the consultant firm of record, general contractor and owner.

3. Certification of installer qualifications demonstrating compliance with the qualifications requirements indicated. Include a list of 5 similar completed projects with addresses of the project location, date of project completion, and contact information of the consultant firm of record, general contractor and owner.

4. Certification from the manufacturer stating that galvanizing has been completed in accordance with these specifications.

5. Certification of welder qualifications in accordance with the American Welding Society Code for Building Construction.

6. When requested by the ENGINEER, furnish other certifications as may be required to demonstrate compliance with the Contract Documents.

E. Shop Drawings and Design Calculations: Complete Shop Drawings showing location and details of installation, and design calculations.

1. Shop Drawings and Design Calculations shall be prepared, signed, and stamped by a professional civil or structural engineer registered in the State of Washington.

2. Shop Drawings shall be drawn to sufficient scale, showing fully-dimensioned layout, including plans, sections, elevations and details of construction, connections to the foundation, joints, penetration details, preformed metal closures, flashing, gutters, and downspouts, fastenings, system caulking, sealants, gaskets, appurtenances, locations of framed openings, special project specific conditions, location of custom-cut panels, provisions for expansion and contraction, connections, accessories, and trim.

   a. Shop Drawings shall include material descriptions, finish, color, details of construction, installation, and accessories of each pre-engineered metal building and shall include, as a minimum:

      1) Erection drawings with written procedures to clearly explain proper installation of fasteners, trim, gaskets, and sealants. Erection drawings shall also include a notation requiring the installer to coordinate with other trades.

      2) Transverse cross sections.

      3) Roof plans showing sizes and locations of structural panels and connections.

      4) Design and detail penetrations to be weathertight. Coordinate locations of penetrations.

      5) Manufacturer's standard details may be used in addition to the shop drawings listed above provided that the portions that apply are clearly marked and those parts that do not apply are clearly marked.

      6) Foundation and floor slab drawings.

a) Foundation anchor bolt plan with anchor bolts, shear lugs (if required) and base plate details. A diagram shall be included showing the vertical and lateral loads applied on the foundation for each load combination.

b) Floor slab drawings shall show the location of all construction joints, blockouts and details of the interface between the foundation and floor slab.

3. Design Calculations

a. Design calculations shall include a complete stress and deflection analysis of all structural components and connections.

b. Design calculations shall include supporting information for the structural roof deck with ICC-ES/IAPMO approval substantiating the capacity of the deck to act as a roof diaphragm and provide lateral support for out-of-plane loading as necessary.

c. Design calculations shall substantiate a complete load path for the wind and seismic lateral force resisting system including design of drag, collector and bracing elements (including connections) required to transfer loading, including overstrength factors, to the foundation. The design calculations shall specifically address anchorage of the structural system to the foundation, including detailing of baseplates and anchor rods. Detailing shall consider edge distance and clearance requirements at slab edges, blockouts and curbs.Design calculations shall include the verification of the adequacy of the foundations and/or corbels' capacity to support the structural roof deck.

d. Specifications for the painting system including paint manufacturer's name, product trade name, and preparation for shop and field coats.

F. Deferred Approval: The shop drawings and design calculations shall be submitted to the Building Official(s) having jurisdiction for review and approval prior to construction. The CONTRACTOR shall provide all engineering support as necessary during the review process with all Building Official(s) having jurisdiction, including providing responses to review comments, attendance at meetings, and submitting all requested documentation.

G. Samples: The CONTRACTOR shall submit 2 samples of each of the following. Unless otherwise indicated, samples shall be full size and shall show gauges, configuration, construction, finish and color proposed for the various components. Samples shall be clearly marked to show the manufacturer's name, product identification, finish and color. New samples shall be resubmitted of each, as required, until approved by the ENGINEER. Upon approval, the samples shall become the standard for acceptance for the project with regard to color, finish, and quality of each item. Approval of samples shall not relieve the CONTRACTOR from compliance with the Contract Documents.

1. Metal Roof Panels

a. Assembled half panels, with representative panel support framing, showing seam, and appurtenances; one-foot long, in color and finish indicated.

b. Three-inches (76 mm) by 4-inch (102 mm) color samples showing substrate, finish, and color.

2. Gutter and downspout: One-foot (.30 m) long section of each in material, profile, finish, and color indicated.

3. Finish trim, closure pieces, and sealant, one-foot long (.30 m) each.

4. Samples of each type fastener required, identified as to use.

1.4 QUALITY ASSURANCE

A. Single Source Responsibility: Pre-engineered metal buildings and components shall be provided by a single manufacturer.

B. Manufacturer Qualifications

1. Pre-engineered metal building manufacturer shall be a current member of the Metal Building Manufacturer's Association (MBMA).

2. Pre-engineered metal building manufacturer shall have a minimum of 20 years of Pre-engineered metal building manufacturing experience.

3. Pre-engineered metal building manufacturer shall have a minimum of 5 similar successful projects over the most recent 10 years, employing similar products, materials, applications, and performance requirements.

4. Manufacturers without these qualifications will not be accepted.

C. Installer Qualifications

1. Installer shall have a minimum of 5 years' experience in the successful completion of at least 5 projects of similar size and scope, employing similar products, materials, applications, and performance requirements.

2. Installer shall be trained, certified, and authorized by the manufacturer to install the manufacturer's product.

3. Installers without these qualifications will not be accepted.

1.5 SPECIAL WARRANTY PROVISIONS

A. For pre-engineered metal buildings and appurtenances furnish manufacturer's 5-year written warranty to cover defects in materials, products, and manufacturing workmanship.

B. Installation Warranty: At the time of Substantial Completion, the manufacturer shall warrant that the installation is not defective in and conforms to the manufacturer's erection drawings, except for reasonable variances not impairing the usefulness thereof.

C. Finish Warranty: The manufacturer shall warrant against spalling, fading, chalking, peeling, cracking, checking, chipping, or erosion to base metal of the exterior roof panel finish, for a period of 10 years from the date of Substantial Completion. The finish shall

not change color more than eight NBS units for a period of 10 years from the date of Substantial Completion.

D. Weathertight Warranty: Manufacturer shall provide a weathertight warranty against water penetration of the pre-engineered metal building system, including panel joints and trim conditions for a period of 20 years from date of Substantial Completion.

E. In the event that the pre-engineered metal building fails to meet the warranty standards above, the manufacturer shall, at the manufacturer's sole cost (including labor and materials), replace or repair the pre-engineered metal building, as agreeable to the OWNER throughout the term of the warranty.

F. The CONTRACTOR shall furnish separate, but concurrently running, 5-year written warranty to cover installation and associated labor.

G. The term of the warranties shall begin on the date of Substantial Completion, unless otherwise indicated.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Structural Requirements

1. Pre-engineered metal building(s), including structural framing, accessories, related assemblies, components, appurtenances and attachment details shall comply with the CODE and shall be designed and installed for resistance to the structural design criteria indicated in the Contract Documents in accordance with the CODE. Where a conflict occurs between the requirements of this Section and the CODE, the more stringent shall apply.

    a. Refer to Section 01 33 17 – Structural Design, Support, and Anchorage for additional design criteria.

2. The CONTRACTOR shall provide additional non-standard bracing, reinforcements, anchors, and heavier gauge materials in order to conform to the structural design criteria indicated and to other performance requirements indicated.

3. Pre-engineered metal building(s) including related assemblies, components, and accessories shall be manufactured and installed to maintain the specified performance requirements, under the structural design criteria indicated, without defects, damage, or failure.

B. Thermal Movements: Pre-engineered metal building(s) and accessories shall be designed to provide for such expansion and contraction of component materials as will be caused by temperature changes without causing buckling, stresses or other cladding components, failure of joints, undue stress on structural elements, damaging loads on fasteners, reduction of performance, or other visual or technical detrimental effects.

C. Manufacturer and Product, or Equal

1. Subject to the requirements indicated, provide manufacturer and product listed below, or equal.

a. **HCI Steel Buildngs or Butler Manufacturing Company** - With additional options and custom features as specified herein.

D. Description

1. Pre-engineered metal building(s) shall be provided complete, and shall include the structural framing, connections, anchor bolts, framed openings for roof penetrations, metal roofing, gutters and downspouts, pipe flashing, gable trim, flashing, closures, fasteners, sealants, and all other component parts for a complete weathertight, exterior envelope. Additional requirements include the method for attaching predator prevention cables and netting for spawning area canopy at the lower raceway.

a. Dimensions: The dimensions shall be as indicated on the Contract Documents. The minimum clear height to the underside of the roof members at their lowest point (eave height) shall be as indicated on the Contract Documents. The roof slope shall be a minimum of ½ inch per foot and meet code requirements.

b. Structural System

1) The building's structural system shall be a clear span rigid frame system as determined by the manufacturer and in coordination with the Contract Documents.

2) The building's structural system shall be selected such that it is compatible with the foundation system shown on the Contract Documents.

2.2 MATERIALS

A. Metals

1. Members fabricated from plate or bar stock: provide 42,000-psi minimum yield strength and comply with the requirements of ASTM A529, A1011, or A572.

2. Members fabricated by cold forming: ASTM A 1008, Grade 50.

3. Galvanized Steel Sheet: ASTM A 653 with G90 coating.

4. Bolts for Structural Framing: ASTM F3125 Grade A325.

5. Anchors into concrete: ASTM F1554 Grade 36

6. Hot rolled structural shapes: ASTM A36, A570, or A992.

2.3 DESIGN CRITERIA

A. Design Loads

1. Roof live load, Wind load, and Seismic load shall be per the design criteria listed on the Structural General Notes Drawing GS-1

2. Collateral loads shall include dead and live loads resulting from HVAC, piping, and other items suspended from the roof. This loading shall be coordinated with the drawings of all disciplines and manufacturer's shop drawings.

B. Design Requirements

1. Design roof panels and exterior covering materials for applicable loads and combinations of loads in accordance with the MBMA Metal Building Design Manual.

2. For design of light gage steel members, comply with AISI for design requirements and allowable stresses.

3. Welded connections shall comply with AWS.

4. Design framing to withstand stresses resulting from combinations of loads that produce the maximum allowable stresses in that member as prescribed in MBMA's Metal Building Design Manual.

2.4 FOUNDATION AND FLOOR SLAB

A. The foundation and floor slab shall be reinforced concrete conforming to the requirements of the CODE and shall be provided by the CONTRACTOR.

B. The pre-engineered metal building manufacturer shall design the anchorages for the pre-engineered metal building and make any recommendations for base plate revision based on actual loading. The CONTRACTOR shall coordinate the anchorage and base plate details with the foundation and pre-engineered metal building engineer.

C. The CONTRACTOR shall coordinate the details of anchorages of the pre-engineered metal building to its foundation. The CONTRACTOR shall provide the anchor bolts and layout templates and allow for any foundation revisions necessary to adapt or support the pre-engineered metal building during construction as accepted by the ENGINEER.

2.5 STRUCTURAL FRAMING

A. Manufacturer and Product, or Equal

1. Subject to the requirements indicated, provide manufacturer and product listed below, or equal.

a. **HCI Steel Buildngs**

b. **Butler Manufacturing Company**

B. Description

1. Design of the structural system for the pre-engineered metal buildings shall be clear span rigid frame with tapered columns, tapered roof beams, and gable roof.

2. Primary Framing

a. Rigid Frames

1) Frames shall consist of welded plate section columns and roof beams complete with necessary splice plates for bolted field assembly.

2) Welding shall be performed in accordance with the American Welding Society Code for Building Construction.

3) All base plates, cap plates, compression plates, and stiffener plates shall be factory-welded into place and have the connection holes shop fabricated.

4) All splice plates shall be shop fabricated complete with bolt connection holes.

5) Columns and roof beams shall be fabricated complete with holes in webs and flanges for the attachment of secondary structural members and bracing.

b. All bolts for field assembly of frame members shall be high strength bolts as indicated on erection drawings.

c. Endwall Structurals

1) Endwall frames shall consist of endwall corner posts, endwall roof beams, and endwall posts as required by design criteria.

a) All splice plates and connection clips shall be shop fabricated complete with bolt connection holes.

b) Beams and posts shall be shop fabricated complete with holes for the attachment of secondary structural members.

3. Secondary Structural Members

a. Purlins and Girts

1) Purlins and girts shall be 8-inch (203 mm) or 9-1/2-inch (241 mm) deep "Z" sections, precision roll formed.

2) Outer flange of all purlins and girts shall contain factory-punched holes for panel connections.

b. Eave Struts

1) Eave struts shall be 8-inch (203 mm) or 9-1/2-inch (241 mm) in deep "C" sections.

2) Outer flange of all eave struts shall contain factory-punched holes for panel connections.

c. Bracing

1) Diagonal bracing shall be designed by the building manufacturer and attached to columns and roof beams.

2) Flange braces, sag angles, etc., when required, shall be supplied by the building manufacturer.

3) All bracing locations shall be coordinated with ductwork, piping, door openings, and ventilation openings.

4. Structural Painting

a. Structural steel shall be shop prepared, shop primed, and field painted prior to erection. For additional requirements, see Section 09 96 00 - Protective Coating. Primer products shall be compatible with paint system specified in Section 09 96 00– Protective Coating.

1) Primary Frames - Clean all steel per SSPC-SP2. Apply one coat of water reducible alkyd primer by spray or dip method to a minimum coating thickness of 1.0 mil.

2) Secondary Structurals - Clean all steel per SSPC-SP8. Apply one coat of coil applied polyester primer to a minimum coating thickness of 0.5 mil (purlins and grits).

2.6 METAL ROOF AND WALL PANELS

A. Manufacturer and Product, or Equal

1. Subject to the requirements indicated, provide manufacturer and product listed below, or equal.

a. **HCI Steel Buildngs; HHR 36”**

b. **Butler Manufacturing Company**; MR-24, Butlerib II

B. Description

1. Panels shall be roll formed to provide a width coverage of 24-inches or 36-inches (610 or 915 mm).

a. There shall be two major corrugations, 2-inches (51 mm), spaced 12-inches (305 mm) on center or there shall be three major corrugations, 2-inches (51 mm), spaced 12-inches (305 mm) on center.

b. There shall be minor corrugations, spaced 6-inches (152 mm) on center between and perpendicular to the major corrugations.

2. The panel endlaps shall be 6-inches (152 mm).

a. Panels shall be of maximum length so as to minimize panel endlaps.

b. Endlaps shall be engineered to occur over and be fastened to a secondary structural member.

c. The upper end of all panels shall be marked for the proper location of endlap sealant.

3. Ridge assembly shall be designed to allow for expansion and contraction.

4. Eave panels shall extend beyond the building structural line.

5. Panels shall be factory pre-punched at panel ends to match pre-punched holes in the eave structural members. Panel end splices shall be factory pre-punched and pre-notched. Panel end splices shall allow for expansion and contraction of the panels.

6. Panel Material

   a. Panel material shall be 24-gauge galvanized steel (80,000 psi yield) G90 coating conforming to ASTM Galvanized Specification A-525.

2.7 ROOF PANEL FINISH AND COLOR

A. Finish: Exterior panel surface shall be **Butler-Cote 500 FP** (70% Kynar 500 fluoropolymer), or equal.

1. Interior surface finish shall be manufacturer's standard polyester paint finish on reverse face.

B. Color shall be selected and approved by the OWNER from manufacturer's full color range including custom colors, and may be required to exactly match other building components, as determined by the OWNER, at no additional cost to the OWNER.

1. Tentative color selection: Provide standard color palettes with product submittals for selection by the OWNER. Tenatively, colors shall be as follows.

Metal Roof Panels	
Exterior:	Brown
Interior:	Brown

2. The OWNER reserves the option of changing this tentative color selection during the submittal process.

3. Color shall be uniform with no variation in shade, and panels of different color batches will not be acceptable.

2.8 BUILDING ACCESSORIES

A. Accessories

1. Accessories shall be manufacturer's standard unless otherwise indicated. Location of standard accessories shall be indicated on the erection drawings.

   a. All miscellaneous trim and accessories shall match adjacent panels.

   b. Skylights shall be insulated lite panels as compatible with MR-24 roof panel systems.

1) Lite panels shall be translucent cool white, fiberglass reinforced, insulated, plastic panel. The panel shall provide diffused natural light and maintain a weathertight roof system.

2) Provide number of skylights in locations as shown on the drawings.

3) Panels shall be nominal 2-feet 0 inches (61 cm) or 3-feet 0 inches (91 cm wide) by 10-foot 6 inches (3.2 m) long.

4) Load capacity shall equal or exceed that of roof panels.

5) Interior and exterior faces of insulated panel shall be factory assembled and sealed, forming a 1-inch (25 mm) dead air space.

c. Gutters, downspouts, and trim pieces shall be provided by the manufacturer.

d. Trim materials shall be:

1) Outside corner trim shall be of the same material and finish as the exterior of wall panel.

2) Gutters, downspouts, eave trim and gable trim shall be prepainted galvanized steel.

B. Roof Fasteners

1. Insulation, bearing plates, and panel clips shall be fastened to structural members with fasteners as per manufacturer's erection drawings, using factory pre-punched holes in structural members.

2. All connections of panels to structural members except at eave shall be by clips with moveable tabs that are seamed into the standing seam sidelap.

3. Panel clips shall be fastened to structural members with fasteners as per manufacturer's erection drawing, using factory pre-punched holes in structural members.

C. Sealants

1. Factory applied side lap sealant shall be a one part, non-skinning, non-drying, synthetic butyl elastomer.

2. Field applied hidden sealant at side laps, end laps, and flashing details shall be gun grade non-skinning butyl elastomer or polymeric non-skinning butyl tape to ensure weather tightness.

3. Exposed sealant shall be as one-part moisture curing, gun grade polyurethane as recommended in writing by the Manufacturer. Color shall match adjacent panels as approved by ENGINEER. Provide custom color as required.

D. Flashing

1. Preformed metal closures, trim pieces, flashings, sheets, clips, and associated appurtenances shall be as indicated or as otherwise required for weather tightness or completeness, and shall be of the same material, color, and finish as the adjacent panels, unless otherwise indicated.

    a. The minimum face dimensions between flashing breaks shall be 12-inches (305 mm). Thermal expansion of exposed items more than 24-feet (7.3 m) in continuous length shall be accommodated and watertight expansion joints shall be provided at approved locations.

    b. Expansion joints shall be fabricated as approved of materials to match the flashing.

    c. Flashing and trim shall be minimum 20-gauge, formed, extruded metal fabricated with the same finish and color as the exterior face of the adjacent panels, unless otherwise indicated.

    d. WORK shall be coordinated as required to insure proper flashing and seals to adjoining construction.

    e. Flashing shall be provided for penetrations. Provide penetration enclosures, including hot pipe penetrations, to be weathertight. Coordinate locations of protruding pipes.

PART 3 -- EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in manufacturer's original, unopened packages, containers, or bundles with labels intact, which clearly identify contents.

1. Materials shall be delivered to Site in a dry and undamaged condition and unloaded per the manufacturer's instructions. The installer shall inspect materials for damage and stains upon arrival to the Site.

B. Store materials carefully in accordance with the manufacturer's written instructions, in an area that is protected from deleterious elements, and in a manner that will prevent damage to the products.

C. Verify that foundation, floor slab, mechanical and electrical utilities, and placed anchors are in correct position.

3.2 PRODUCT CONDITIONS

A. Comply with manufacturer's written instructions for environmental conditions before, during and after installation.

B. Protect surrounds WORK from damage that may result from operations under this Section.

3.3 INSPECTION

A. The CONTRACTOR shall be totally responsible for the proper performance and completion of the WORK under this Section.

B. The CONTRACTOR shall inspect materials for damage and shall confirm conformance with the specifications, erection drawings, and shop drawings prior to installation.

C. Systems and components shall be inspected before installation.

1. Damaged or defective items shall be rejected and marked as such and shall be removed from the Site.

2. Exposed surfaces that exhibit pitting, seam marks, roller marks, stains, discoloration, or other surface imperfections on the finished units shall be rejected.

D. The CONTRACTOR shall verify dimensions, tolerances, and method of attachment with adjacent WORK.

1. Examine substrates, areas, and conditions where metal roof and soffit panels, system support framing, and appurtenances will be installed for compliances with the requirements for installation, taking into account tolerances, and other conditions affecting performances of installed metal panels and appurtenances.

a. Provide inserts, backing blocking, anchoring devices, and reinforcements that must be built into other WORK for the installation of metal roof and soffit panels, system support framing, and appurtenances. Coordinate delivery with other WORK to avoid delay.

b. Prior to installing the pre-engineered metal buildings the CONTRACTOR and the pre-engineered metal building installer shall verify final alignment of the foundation, floor slab, mechanical and electrical utilities to be in compliance with these specifications with the Contract Documents, with the erection drawings, and with the shop drawings.

2. Notify the ENGINEER in writing of conditions detrimental to the proper and timely completion of the WORK. Do not proceed with the WORK until satisfactory conditions have been corrected in an acceptable manner.

3. Commencement of the installation by the CONTRACTOR shall indicate CONTRACTOR's acceptance of the substrate, areas, and conditions.

3.4 FABRICATION

A. The buildings shall be factory fabricated and erected to the manufacturer's written standards and shall be in accordance with AISC and MBMA standards.

B. The prefabricated buildings shall be completely fabricated and prepared for shipment including any necessary crating or bundling. All parts of the buildings shall be accurately made and true to dimension so that all parts will easily fit during installation.

3.5 PREPARATION

A. Sequence installation properly with the installation and protection of other WORK, so that neither will be damaged by the installation of the other.

3.6 INSTALLATION

A. General

1. Installation shall comply with the requirements of the Contract Documents, with applicable references, with AISC, AISI, MBMA, with the requirements of the CODE, and with manufacturer's written instructions. Where a conflict occurs among these requirements, the more stringent shall apply, as directed by the ENGINEER.

2. The CONTRACTOR shall provide corrosion resistant fasteners, anchors, and shims required for a complete installation, and shall be secure, plumb, level, straight, and true to line, allowing for required movement, including expansion and contraction.

3. The CONTRACTOR shall provide separation of dissimilar materials to ensure no galvanic action occurs.

4. Horizontal lines shall be level, and vertical lines shall be plumb.

5. WORK shall be coordinated as required to insure proper flashing and seals to adjoining construction.

B. Installation and Erection: Installation and erection of the buildings shall be in accordance with the manufacturer's standards and shall be workmanship of the highest quality. No field cutting of structural parts will be permitted. Field cutting and patching of roof panels and accessories will not be permitted unless authorized by the ENGINEER. Such field modifications, when authorized, shall be performed in a manner which will not impair the appearance, weather tightness, or structural quality of the material. Erection shall be accomplished in sufficient time to meet the schedule specified.

3.7 ROOF PANELS

A. General: Apply panels and associated items for neat and weather tight enclosure. Avoid "panel creep" or application not true to line. Protect factory finishes from damage.

1. Flash and seal roof panels at eave and rake with rubber, neoprene or other closures to exclude weather.

B. Roof Panel Application

1. Panels shall be factory cut-to-length according to the erection drawings as furnished by the manufacturer.

2. Panels shall be positioned and aligned to hold the 24-inch (610 mm) or 36-inch (915 mm) module throughout the building length.

3. Pre-punched panels shall be positioned and aligned by matching the pre-punched holes in the panel with the pre-punched roof structural.

4. Panel sidelaps shall be field seamed; all sidelap sealant shall be factory applied.

5. Endlaps will be at least 6-inches (152 mm) and fastened together over and to structural members.

6. Panel sidelaps and endlaps shall be sealed with weather sealing compound to prevent the entry of capillary moisture.

7. Fasteners shall be installed with proper tools, in a workmanlike manner according to the recommendations of the Manufacturer.

3.8 WALL PANELS

A. Wall Panel Application

1. Structural system shall be plumb before wall panels are attached.

2. Panels shall be aligned and attached in accordance with the erection drawings.

3. Sidelaps shall be at least one corrugation.

4. Panels shall be closed at base by metal closure.

3.9 CLEANING, FINISHING, AND PROTECTION

A. Adhesive papers used for masking which become firmly bonded when exposed to heat and/or light shall not be used.

1. Remove masking film and temporary labels as soon as possible after installation. Films and labels left in place after installation shall be the responsibility of the CONTRACTOR.

2. Residue shall not be left on any surfaces.

B. Upon completion of the installation of pre-engineered metal buildings and appurtenances shall be cleaned of dirt and other foreign matter to the satisfaction of the ENGINEER.

C. Cleaning shall be performed again immediately prior to acceptance of the WORK, as determined by the ENGINEER.

1. Cleaning shall be performed in accordance with the manufacturer's written instructions.

2. Pre-engineered metal buildings shall be protected from damage from subsequent construction operations.

D. The CONTRACTOR shall make adjustments required until accepted.

E. The CONTRACTOR shall remove scratches and blemishes to the satisfaction of the ENGINEER.

F. Damaged or defective items shall be removed and replaced at the direction of the ENGINEER.

G. When pre-engineered metal buildings WORK are completed, remove unused materials, containers, and equipment, and clean the Site of debris.

END OF SECTION

SECTION 22 10 10 – PLUMBING, PIPING, AND SPECIALTIES

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide plumbing piping and specialties, complete and operable, as indicated in accordance with the Contract Documents.

1.2 WORKMANSHIP AND MATERIALS

A. WORK shall in strict accordance with the International Plumbing Code and codes of the State of Washington, and any other authorities having jurisdiction.

B. The CONTRACTOR shall have required certifications and shall be thoroughly familiar with the local codes.

C. Protection

1. Care shall be taken at all times to protect floors, stairways, and walls during the make-up and installation of piping and equipment.

2. The CONTRACTOR shall remove stains and repair damage before final acceptance of the WORK.

D. Identifying Marks

1. If the ENGINEER finds materials that have identifying marks removed or lack such marks completely, such items will be rejected until the CONTRACTOR has furnished proof that said items conform to the Specifications.

2. Adequacy and extent of such proof will be determined by the ENGINEER.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Plumbing piping, fixtures, specialties, and equipment shall be as recommended by the manufacturer for the intended usage.

2.2 HANGERS, SUPPORTS, AND MISCELLANEOUS METAL WORK

A. General

1. For utility piping the CONTRACTOR shall provide hangers and supports for vertical, axial, and seismic loads in accordance with the Code.

2. Pipe supports shall be as indicated in Section 40 05 07 – Pipe Supports.

2.3 HOSE BIBBS AND HYDRANTS

A. Hose bibbs and hydrants in exposed locations subject to freezing shall be the non-freeze type.

B. Hose bibbs shall be provided with vacuum breakers as furnished by **Crane Co., American Standard**, or equal.

C. Manufacturers, or Equal

Drawing Callout	Fixture Type	Description
HB-2	Non-Freeze Hydrant, Wall-Type	Heavy duty bronze hydrant with nickel-bronze face, hinged cover, recessed box, and key. Length to suit wall. **1. Jay R. Smith Mfg. Co., Fig. 5509** 2. **Josam Mfg. Co.,** 3. **Zurn Industries, Inc.,**
HB-3	Hose Hydrants	Heavy duty bronze hydrant, with composition disc, handwheel, cap and chain. Sizes 1-1/2 inch and 2-1/2 inch: 1. **Fire-End and Croker Corp, Model 5010**
HB-4	Non-Freeze Hydrant, Post-Type	Exposed bronze hydrant, post-type, depth of bury to suit local conditions; minimum 4-feet. 1. **Woodford Manufacturing Co., Model Iowa Y1**

2.4 RACKS

A. The CONTRACTOR shall furnish hose racks where shown in the drawings and as detailed.

2.5 PAINTING

A. Ferrous metal, except finished, galvanized, and machined surfaces, shall have surfaces prepared and primed in the shop in accordance with the requirements of Section 09 96 00 – Protective Coating.

B. Prime colors shall be compatible with finish coats that are applied in the field.

C. Self-contained units such as wall-mounted hose racks shall be supplied with factory-applied finish coats of baked enamel.

D. Field painting shall comply with the requirements of Section 09 96 00 – Protective Coating.

PART 3 -- EXECUTION

3.1 PREPARATION

A. The CONTRACTOR shall coordinate the roughing-in process with provisions for wall and floor sleeves, pipe inserts, and cutting of roof and floor penetrations, such that drain lines will have the required invert elevations and slopes.

3.2 INSTALLATION AND APPLICATION

A. The CONTRACTOR shall provide plumbing specialties in accordance with manufacturer's printed instructions.

B. Pipe shall be arranged in a neat and orderly manner to occupy the minimum amount of space and so that the pipe will not obstruct passageways and movement of building occupants or interfere with normal operation and maintenance of any equipment.

C. Pipe shall be carefully placed and properly sloped and shall be neatly and firmly supported by hangers or supports.

D. Piping in buildings shall be as close to the ceilings or walls as possible unless indicated otherwise.

E. Joints

1. Screwed joints shall be made with joint compound and be tight and leakproof.

2. A sufficient number of brass-to-ferrous metal seat unions shall be placed in lines such that any pipe, valve, or piece of equipment may be easily disconnected.

F. Install warning sign for non-potable water at all hose bibb locations.

3.3 EQUIPMENT DAMAGE AND REMOVAL

A. The CONTRACTOR's operations shall be carried out in such a manner as to guard against damage to those portions of the structure and equipment that are to remain in the finished WORK.

B. Any damage caused by the CONTRACTOR or Subcontractor through their operations shall be repaired to the satisfaction of the ENGINEER.

END OF SECTION

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SECTION 22 63 14 – OXYGEN PIPING SYSTEMS

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall provide oxygen piping, complete and in place, in accordance with the Contract Documents.

B. The requirements of Section 40 05 00 – Piping General, apply to the Work of this Section.

1.2 CONTRACTOR SUBMITTALS

A. The CONTRACTOR shall furnish submittals in accordance with the requirements of Section 01 33 00 – Submittal Procedures.

1. Product data for all materials. Include details of double containment and termination fittings.

2. Manufacturer's storage, transportation, installation, and testing instructions.

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

40 05 00	Piping General
40 05 07	Pipe Supports

B. Reference Standards

American National Standards Institute (ANSI)	
ANSI B 16.18	Cast Copper Alloy Solder Joint Pressure Settings
American Society of Mechanical Engineers (ASME)	
ASME B 1.20.1	(2018) Pipe Threads, General Purpose (Inch)
ASME B 16.22	(2021) Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings
ASME B 16.24	(2021) Cast Copper Alloy Pipe Flanges, Flanged Fittings, and Valves Classes 150, 300, 600, 900, 1500, and 2500
ASME B 16.26	(2018) Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B 31.1	(2022) Power Piping

PART 2 -- PRODUCTS

2.1 PIPE MATERIAL

A. Oxygen piping shall be Type K copper tube in accordance with ASTM B 819 - Seamless Copper Tube for Medical Gas Systems, furnished in factory-cleaned, sealed, and capped lengths.

2.2 JOINTS

A. Unless otherwise indicated, joints on oxygen piping shall be brazed joints of silver solder. No solders containing more than 0.2 percent of lead shall be used.

Fittings

B. Solder Fittings: Silver-soldered fittings shall conform to ANSI B 16.18 - Cast Copper Alloy Solder Joint Pressure Fittings, or to ASME B 16.22 - Wrought Copper and Copper Alloy Solder - Joint Pressure Fittings. The soldering flux shall be the manufacturer's approved type for oxygen service.

C. Flared Fittings: Flared fittings shall conform to ASME B 16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.

D. Compression Fittings: Compression type fittings shall be brass fittings as manufactured by SWAGELOK, Parker Hannifin - CPI, or equal.

E. Flanged Fittings: Cast copper alloy flanges and flanged fittings shall be in accordance with ASME B 16.24 - Cast Copper Alloy Flanges and Flanged Fittings, and ASTM B 62 - Composition Bronze or Ounce Metal Castings, with 150 lb. rating, or as indicated.

2.3 DOUBLE CONTAINMENT FOR BURIED PIPING

A. The double containment piping shall be a system of pipe and fittings designed for the containment of fluids leaking from an interior carrier pipe. It shall be constructed such that one primary pipe may be fitted into the inner space of the double containment pipe. Refer to the Drawings for the carrier and double containment pipe materials. The pipe design shall allow for a minimum 0.5-inch clearance at the bottom of the pipe throughout the system. The pipe annulus shall be designed with sufficient clearance and be free of sharp edges and angles. Clearances shall take into account the opening under the centralizers; the amount of space at the inside radius and branches, elbows, and sweeps; the size of weld or glue beads and/or couplings; and the actual space between the inner and outer pipe dimensions. Centralizers shall fully support the carrier pipe. The complete double containment system shall have bonded (glued) joints and shall be gas tight to a minimum of the 5-psig test pressure.

B. Termination fittings, pressure test fittings, drain and vent port fittings, tees, elbows, drop legs, and other appurtenances shall be provided as required by the Drawings and to obtain a fully functional system with each pipe run individually tested. The double containment piping system shall be a complete system of straight pipe and fittings which are supplied by a single manufacturer. The carrier pipe need not be provided by the double containment system manufacturer, but method of assembly of the carrier pipe shall be accounted for in the design and provision of the double containment system components. Termination fittings shall seal the carrier and containment piping at all ends of containment. Sample taps (each including nipple, ball valve, nipple, and threaded cap) shall be provided where required to detect carrier pipe leakage at all low ends of piping and at least on one end of flat profile piping. Where the carrier pipe does not pass out of the ends of the containment pipe, the termination fitting shall seal the containment pipe.

C. Expansion fittings shall be provided by the double containment system manufacturer for all above grade double contained piping. Expansion fittings shall be sized and spaced to accommodate temperature changes from 70 to 30 degrees F and 70 to 120 degrees F. A minimum of one expansion fitting shall be provided for every 50 feet of outdoor, unshielded piping above grade. Provide expansion fittings if required to make closures below ground, in buildings, and in vaults or trenches.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. General: Oxygen piping shall be installed in a neat and workmanlike manner, properly aligned, and cut from measurements taken at the Site to avoid interferences with structural members, architectural features, openings, and equipment. Exposed tubing shall afford maximum headroom and access to equipment. Installations shall be in accordance with applicable safety requirements.

B. Supports and Anchors: Tubing shall be firmly supported with fabricated or commercial hangers, brackets, or supports in accordance with Section 40 05 07 - Pipe Supports. Where necessary to avoid stress on equipment or structural members, the tubes shall be anchored or harnessed. Expansion joints and guides shall compensate for expansion due to temperature differences.

C. Valves and Unions: Unless otherwise indicated, tubing to equipment shall be provided with a shutoff valve and union, unless the valve has flanged ends. Unions shall be provided at threaded valves, equipment, and other devices requiring occasional removal or disconnection.

D. Double Containment Piping:

1. Double containment piping shall be laid to the grades shown on the Drawings and shall be uniformly sloped to the leakage monitoring points. Assembly shall be in accordance with the manufacturer's written instructions. The carrier piping shall be assembled in conjunction with the double containment. Provide a termination fitting sealing off the double containment at every point where double containment is stopped. Provide at least one test fitting per run of piping. Double containment piping shall be kept sealed at all times to minimize the introduction of water or water vapor.

2. Leak monitoring points shall be provided with flanges, couplings, penetrations, and fittings as required to allow leak detection as shown on the Drawings.

3. The carrier piping shall be tested and meet its zero-leak requirement before testing the double containment pipe. Purging, drying, and testing the double containment piping shall be completed only with clean, dry air or nitrogen. The dewpoint of such air or nitrogen shall be dried to – 10 degrees F or lower to minimize the introduction of water into the double containment. Testing of the double containment piping shall include pressurizing the piping through a test fitting with 5 psig dry air or nitrogen. A calibrated pressure gauge with a range of 0 to 20 psig shall be provided by the Contractor for testing. The test gauge shall allow accurate readings to 0.5 psig or less. Test duration shall be a minimum of 2 hours. Apply leak detection solution to all exposed joints during the test period. All testing shall be completed in the presence of the OWNER's representative and test reports shall be prepared for each test. Test reports at a minimum shall include the date, time, names of test

participants and witnesses, define the piping tested, define the starting and ending test pressures, and test outcome. No leakage, as indicated on the calibrated pressure gauge is allowed for a successful test. More stringent testing requirements required by the authorities having jurisdiction, if any, shall also be met by the Contractor.

4. Find and replace all faulty joints, fittings, gaskets, and pipe as required to obtain a successful pressure test. Retest after repairs are made.

3.2 PIPE PREPARATION

A. Cleaning: Before erection, oxygen piping, valves and fittings, except those supplied especially prepared for oxygen service by the manufacturer and received sealed on the Site, shall be thoroughly cleaned of oil, grease and other readily oxidizable materials by washing in a hot solution of sodium carbonate or trisodium phosphate made in proportion of one pound to three gallons of water. THE USE OF ORGANIC SOLVENTS, FOR EXAMPLE, CARBON TETRACHLORIDE, IS PROHIBITED. Scrubbing shall be employed where necessary to insure complete cleaning. After washing, the piping, valves, and fittings shall be rinsed thoroughly in clean, hot water. After cleaning, particular care shall be exercised in the storage and handling of pipe and fittings. Pipe and fittings shall be temporarily capped or plugged to prevent recontamination before final assembly. Tools used in cutting or reaming shall be kept free from oil or grease. Where such contamination has occurred, the items affected shall be rewashed and rinsed.

3.3 JOINTS

A. Threaded Joints: Pipe threads connecting to copper tubing fittings shall conform to ASME B 1.20.1 - Pipe Threads, General Purpose (inch), and shall be full and cleanly cut with sharp dies. Not more than 3 threads shall remain exposed after installation.

1. Screw joints used in shutoff valves, including station outlet valves, shall be installed by tinning the male thread with soft solder. Litharge and glycerin or an approved oxygen luting or sealing compound are acceptable.

B. Brazed Joints: Brazed silver solder joints shall conform to the manufacturer's recommendation and the specifications and recommendations of ASME B 31.1 - Power Piping. Brazing shall be done by skilled and qualified welders per Section 40 05 01 - Piping General. Prior to the application of flux, the ends of tubes shall be thoroughly dried and cleaned.

1. Joints in the piping, except those permitted to be approved brass flared-type gas tubing fittings and those at valves or at equipment requiring screw connections, shall be made with silver brazing alloy or similar high melting point (at least 1,000 degrees °F) brazing metal. Particular care shall be exercised in applying the flux to avoid leaving any excess inside the completed joints. The outside of the tube and fittings shall be cleaned by washing with hot water after assembly.

2. After installation of the piping but before installation of the outlet valves, the line should be blown clear by means of oil free dry air or nitrogen.

3.4 INSPECTION AND FIELD TESTING

A. Inspection: Finished installations shall be carefully inspected for proper joints and supports, anchoring, interferences, and damage to tubing, fittings, and coating. Defects shall be repaired.

B. Field Testing: Prior to enclosure or burying, tubing systems shall be pressure tested with nitrogen gas, as required in the Piping Schedule for a period of not less than one hour without exceeding the tolerances listed in the Piping Schedule. Where no pressures are indicated, the tubes shall be subject to 1-1/2 times the maximum working pressure. The Contractor shall furnish test equipment, labor, materials, and devices as part of the Work.

1. Leakage may be determined by loss of pressure, soap solution, chemical indicator, or other positive and accurate method. Fixtures, devices, or other accessories which are to be connected to the lines and which would be damaged if subjected to the test pressure shall be disconnected and ends of the branch lines be plugged or capped as required during the testing procedures.

2. Leaks shall be repaired, and the system shall be re-tested until no leaks are found.

END OF SECTION

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SECTION 23 05 29 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Section Includes:

1) Metal pipe hangers and supports.

2) Trapeze pipe hangers.

3) Thermal-hanger shield inserts.

4) Fastener systems.

5) Outdoor Equipment Stands.

1.2 RELATED DOCUMENTS

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

1.3 RELATED REQUIREMENTS

A. Section 05 50 00 - Miscellaneous Metalwork

1) For structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.

B. Section 23 05 16 - Expansion Fittings and Loops for HVAC Piping, for pipe guides and anchors.

C. Section 23 05 48 - Vibration and Seismic Controls for HVAC, for vibration isolation devices.

D. Section 23 31 13 - Metal Ducts, for duct hangers and supports.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:

1) Trapeze pipe hangers.

2) Equipment supports.

C. Delegated-Design Submittal: For trapeze hangers 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) Detail fabrication and assembly of trapeze hangers.

2) Include design calculations for designing trapeze hangers.

1.5 INFORMATIONAL SUBMITTALS

A. Welding Certificates

1.6 QUALITY ASSURANCE

A. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 -- PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 - Quality Requirements, to design trapeze pipe hangers and equipment supports.

B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1) Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

2) Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

3) Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

2.2 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1) Description: MSS SP-58, Types 1 through 58, factory-fabricated components.

2) Galvanized Metallic Coatings: Pregalvanized, hot-dip galvanized, or electro-galvanized.

3) Nonmetallic Coatings: Plastic coated, or epoxy powder-coated.

4) Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

5) Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Stainless Steel Pipe Hangers and Supports:

1) Description: MSS SP-58, Types 1 through 58, factory-fabricated components.

2) Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

3) Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

C. Copper Pipe and Tube Hangers:

1) Description: MSS SP-58, Types 1 through 58, copper-plated steel, factory-fabricated components.

2) Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-plated steel.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.4 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) National Pipe Hanger Corporation.

2) Pipe Shields Inc.

3) Piping Technology & Products, Inc.

B. Insulation-Insert Material for Cold Piping: ASTM C552, Type II cellular glass with 100-psi (688-kPa)] or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psi (862-kPa) minimum compressive strength and vapor barrier.

C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type anchors for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1) Indoor Applications: stainless steel.

2) Outdoor Applications: Stainless steel.

2.6 OUTDOOR EQUIPMENT STANDS

A. Description: Individual foot supports with elevated adjustable channel cross bars and clamps/fasteners/bolts for ground or roof supported outdoor equipment components, without roof membrane penetration, in a pre-fabricated system that can be modularly-assembled on site.

B. Foot Material: Rubber or polypropylene.

C. Rails Material: Hot dip galvanized carbon steel.

D. Wind/Sliding Load Resistance: Up to 100 mph minimum.

2.7 MATERIALS

A. Aluminum: ASTM B221.

B. Carbon Steel: ASTM A1011/A1011M.

C. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; galvanized.

D. Stainless Steel: ASTM A240/A240M.

E. Threaded Rods: Continuously threaded. Zinc-plated or galvanized steel for indoor applications and stainless steel for outdoor applications. Mating nuts and washers of similar materials as rods.

F. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1) Properties: Nonstaining, noncorrosive, and nongaseous.

2) Design Mix: 5000-psi, 28-day compressive strength.

PART 3 -- EXECUTION

3.1 APPLICATION

A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb .

3.2 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1) Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.

2) Field fabricate from ASTM A36/A36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

D. Fastener System Installation:

1) Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.

2) Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

F. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

G. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

H. Install lateral bracing with pipe hangers and supports to prevent swaying.

I. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

J. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

L. Insulated Piping:

1) Attach clamps and spacers to piping.

a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.

b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.

c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2) Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

3) Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

4) Shield Dimensions for Pipe: Not less than the following:

a. NPS 1/4 to NPS 3-1/2 : 12 inches long and 0.048 inch thick.

5) Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and 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) Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING

A. Touchup: Comply with requirements in Section 09 91 13 - Exterior Painting or Section 09 91 23 - Interior Painting, for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.7 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports and attachments for general service applications.

F. Use stainless steel pipe hangers and stainless steel attachments for hostile environment applications.

G. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.

H. Use padded hangers for piping that is subject to scratching.

I. Use thermal-hanger shield inserts for insulated piping and tubing.

J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1) Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30 .

2) Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.

3) Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.

4) Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4 , to allow off-center closure for hanger installation before pipe erection.

5) Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.

6) Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 .

7) Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.

8) Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.

9) Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.

10) Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3 .

K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1) Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.

2) Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1) Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

2) Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.

3) Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.

4) Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1) Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.

2) Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.

3) Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.

4) Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.

5) C-Clamps (MSS Type 23): For structural shapes.

6) Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.

7) Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.

8) Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.

9) Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.

10) Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.

11) Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1) Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.

2) Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.

3) Thermal-Hanger Shield Inserts: For supporting insulated pipe.

O. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

P. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION

23 34 16 - CENTRIFUGAL HVAC FANS

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) Wall-Mounted Exhaust Fan

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

   1) Construction details, material descriptions, dimensions of individual components and profiles, and finishes for fans.
   2) Rated capacities, operating characteristics, and furnished specialties and accessories.
   3) Certified fan performance curves with system operating conditions indicated.
   4) Certified fan sound-power ratings.
   5) Motor ratings and electrical characteristics, plus motor and electrical accessories.
   6) Material thickness and finishes, including color charts.
   7) Dampers, including housings, linkages, and operators.
   8) Fan speed controllers.

B. Shop Drawings:

   1) Include plans, elevations, sections, and attachment details.
   2) Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3) Include diagrams for power, signal, and control wiring.
   4) Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

C. Delegated Design Submittal: For vibration isolation, supports, and seismic restraints 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) Design Calculations: Calculate requirements for selecting vibration isolators, supports, and seismic restraints.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Fan room layout and

B. relationships between components and adjacent structural and mechanical elements, drawn to scale, and coordinated with each other, using input from installers of the items involved.

C. Seismic Qualification Data: For fans, accessories, and components, from manufacturer.

1) Basis for Certification: Indicate whether withstand certification is based on actual shake table test of assembled components or on calculation.
2) Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity, and locate and describe mounting and anchorage provisions.
3) Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For centrifugal fans to include in normal operation, emergency operation, and maintenance manuals with replacement parts listing.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Unusual Service Conditions

1) Base fan-performance ratings on the following:

a. Ambient Temperature: 68 deg F dry bulb.
b. Altitude: 500 feet above sea level.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 - Quality Requirements, to design vibration isolation, supports and seismic restraints, including comprehensive engineering analysis by a qualified professional engineer, using performance and design criteria indicated.

D. Seismic Performance: Centrifugal fans shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1) The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
2) Component Importance Factor: **1.5** .

2.2 WALL-MOUNT EXHAUST FAN WITH LOUVER

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) McMaster-Carr

B. Description: Light Duty Direct-Drive Wall-Mount Exhaust Fan with Louver

C. Housing:

1) Housing Material: Galvanized steel.
2) Housing Coating: None.
3) Housing Construction: Side panels shall be easily removable for service. Include inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

D. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.

E. Fan Wheels: Aluminum airfoil blades welded to aluminum hub.

F. Louver:
1) Blade Material: Aluminum
2) Type: Gravity-operated

G. Motor Enclosure: Totally enclosed.

H. Accessories:

1) Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
2) Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
3) Volume-Control Damper: Manually operated with quadrant lock, located in fan outlet.

2.3 MOTORS

A. Comply with NEMA designation.

B. Where variable-frequency drives are indicated or scheduled, provide fan motor compatible with variable-frequency drive.

2.4 INTAKE LOUVER

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) McMaster-Carr

B. Description: Fixed blade wall louver
1) Louver shall be sized such that a minimum of 825 cfm can be passed at a velocity of no more than 600 fpm.

C. Blade Material: Aluminum

D. Frame Material: Aluminum

2.5 SOURCE QUALITY CONTROL

A. AMCA Certification for Fan Sound Performance Rating: Test, rate, and label in accordance with AMCA 301.

B. Operating Limits: Classify fans in accordance with AMCA 99, Section 14.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install centrifugal fans level and plumb.

B. Disassemble and reassemble units, as required for moving to the final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

D. Equipment Mounting:
1) Support wall-mounted and other hanging centrifugal fans directly from the building structure.
2) Comply with requirements for vibration isolation and seismic-control devices.

E. Install units with clearances for service and maintenance.

3.2 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 26 05 19 – Wire and Cabling

B. Ground equipment according to Section 26 05 26 - Grounding.

C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1) Nameplate shall be laminated acrylic or melamine plastic signs.
2) Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.3 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring according to Division 26.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Lubricate bearings.

3.5 CLEANING

A. After completing system installation and testing, adjusting, and balancing and after completing startup service, clean fans internally to remove foreign material and construction dirt and dust

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

1) Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2) Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3) Fans and components will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain centrifugal fans.

END OF SECTION

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SECTION 23 82 39.19 – WALL AND CEILING UNIT HEATERS

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 wall and ceiling heaters with propeller fans and electric-resistance heating coils.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, and details.

2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

3. Include details of anchorages and attachments to structure and to supported equipment.

4. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.

5. Wiring Diagrams: Power, signal, and control wiring.

C. Samples: For each exposed product and for each color and texture specified.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wall and ceiling unit heaters to include in emergency, operation, and maintenance manuals.

PART 2 -- PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Chromalox, Inc.

2. Marley Engineered Products.

3. QMark; Marley Engineering Products

2.2 DESCRIPTION

A. Assembly including chassis, electric heating coil, fan, motor, and controls. Comply with UL 2021.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 CABINET

A. Front Panel: Stamped-steel louver, with removable panels fastened with tamperproof fasteners.

B. Finish: Baked enamel over baked-on primer with manufacturer's standard color selected by Architect, applied to factory-assembled and -tested wall and ceiling heaters before shipping.

C. Surface-Mounted Cabinet Enclosure: Steel with finish to match cabinet.

2.4 COIL

A. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in corrosion-resistant metallic sheath. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware, and limit controls for high-temperature protection. Provide integral circuit breaker for overcurrent protection.

2.5 FAN AND MOTOR

A. Fan: Aluminum propeller directly connected to motor.

B. Motor: Permanently lubricated.

2.6 CONTROLS

A. Controls: Low-voltage relay with transformer kit.

B. Electrical Connection: Factory wire motors and controls for a single field connection with disconnect switch.

PART 3 -- EXECUTION

3.1 EXAMINATION

A. Examine areas to receive wall and ceiling unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical connections to verify actual locations before unit-heater installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install wall and ceiling unit heaters to comply with NFPA 90A.

B. Install wall and ceiling unit heaters level and plumb.

C. Install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

D. Ground equipment according to Section 26 05 26 - Grounding

E. Connect wiring according to Section 26 05 19 – Wire and Cabling

END OF SECTION

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SECTION 26 00 00 – ELECTRICAL WORK, GENERAL

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Provide the electrical WORK, complete and operable, as indicated in accordance with the Contract Documents.

B. The provisions of this Section shall apply to all Sections in Division 26, except as otherwise indicated.

C. The WORK of this Section is required for operation of electrically-driven equipment provided under Specifications in other Divisions.

D. 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 Section 26 05 10 – Electric Motors.

E. 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.

F. Equipment supports and foundations shall be in conformance with the requirements of Section 46 01 00 – Equipment General Provisions.

1.2 REFERENCE STANDARDS

NEC (NFPA 70)	National Electrical Code
NETA	International Electrical Testing Association
NEMA 250	Enclosure for Electrical Equipment (1000 Volts Maximum)
WAC 296-46B	Electrical Safety Standards, Administration and Installation

A. Electrical equipment shall be listed by and shall bear the label of Underwriters' Laboratories, Inc. (UL) or an independent testing laboratory acceptable to the local code enforcement agency having jurisdiction.

B. Installation of electrical equipment and materials shall comply with OSHA Safety and Health Standards (29 CFR 1910 and 29 CFR 1926, as applicable), state building standards, and applicable local codes and regulations.

C. Where the requirements of the specifications conflict with UL, NEMA, NFPA, or other applicable standards, the more stringent requirements shall govern.

1.3 SIGNAGE AND MARKINGS

A. Identification

1. Provide danger, caution, and warning signs and equipment identification markings in accordance with applicable federal, state, OSHA, and NEC requirements.

B. Local Disconnect Switches

1. Legibly mark each local disconnect switch for motors and equipment in order to indicate its purpose, unless the purpose is indicated by the location and arrangement.

C. Warning Signs

1. 600 Volts Nominal, or Less

a. Mark entrances to rooms and other guarded locations that contain live parts with conspicuous signs prohibiting unqualified persons from entering.

2. Mark indoor electrical installations that are open to unqualified persons and contain metal-enclosed switchgear, unit substations, transformers, and other similar associated equipment over 600 volts nominal, with appropriate caution signs.

3. Outside Branch Circuits and Feeders over 600 Volts

a. Post warning signs in plain view where unauthorized persons might come in contact with live parts: WARNING – HIGH VOLTAGE – KEEP OUT.

D. Isolating Switches

1. Provide isolating switches not interlocked with an approved circuit-interrupting device with a sign warning against opening them under load.

1.4 PUBLIC UTILITIES REQUIREMENTS

A. Contact the serving utility and verify compliance with requirements before construction.

B. Coordinate schedules and payments for WORK by utilities.

C. Where conduits and conductors in the WORK are indicated to be larger, heavier schedule, or have greater protective coating than utility requirements, provide the larger size, heavier schedule, or greater protection.

D. Provide electrical service as indicated and as required by the serving utility.

E. Verify and provide service conduits, fittings, transformer pad, grounding devices, and service wires not provided by the serving utility.

F. Verify with the utility the exact location of each service point and type of service, and pay charges levied by the serving utilities as part of the WORK.

1.5 PERMITS AND INSPECTION

A. Obtain permits and pay inspection fees as required for project completion. This includes scheduling and paying for inspections with Washington State Department of Labor & Industries.

1.6 CONTRACTOR SUBMITTALS

A. General

1. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals.

2. Custom-prepare Shop Drawings.

3. Drawings or data indicating "optional" or "as required" equipment will not be accepted.

4. Cross out options not proposed or delete from the Shop Drawings.

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 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

C. Catalog Cuts

1. Submit catalog cuts or photocopies of applicable pages of bulletins or brochures for mass produced, non-custom manufactured material.
2. Stamp the catalog data sheets in order to indicate the Project name, applicable Specifications Section and Paragraph, model number, and options.

D. Materials and Equipment Schedules

1. Within 30 Days of the commencement date in the Notice to Proceed, deliver to the ENGINEER a complete list of materials, equipment, apparatus, and fixtures that are proposed for use.
2. Include in the list the type, size, name of manufacturers, catalog number, and such other information as required to identify the item.

E. Technical Manuals

1. Submit complete information in accordance with the requirements of Section 01 33 00 – Contractor Submittals.
2. As-Built Drawings

   a. Prepare as-built drawings, showing invert and top elevations and routing of duct banks and concealed below-grade electrical installations.

   b. Furnish the drawings to the ENGINEER in accordance with the requirements of Section 01 33 00 – Contractor Submittals.

1.7 AREA DESIGNATIONS

A. General

1. Designations for raceway system enclosures shall comply with the requirements of Section 26 05 33 – Electrical Raceway Systems.
2. Designations for electrical WORK specifically indicated in other Sections shall comply with the requirements of those Sections unless indicated otherwise.
3. Designations for other electrical WORK not included in the above Paragraphs shall be as follows:

AREA	MINIMUM NEMA ENCLOSURE CLASSIFICATION					
	1	3R	4	4X	12	Notes
Indoors					**X**	Painted steel
Outdoors				**X**		Stainless steel
Outdoors		**X**				Transformers only. Painted steel.

4. Designations for electrical WORK not included in the above Paragraphs shall be NEMA 4X.

B. Material Requirements

1. Construct NEMA 4X enclosures of Type 304 or 316 stainless steel.
2. Do not coat stainless steel enclosures.

1.8 TESTS

A. The CONTRACTOR shall be responsible for factory and field tests indicated in Division 26, as required by the ENGINEER, and as required by other authorities having jurisdiction.

B. Furnish necessary testing equipment.

C. Pay the costs of the tests, including replacement parts and labor, due to damage resulting from damaged equipment or from testing and correction of a faulty installation.

D. Reporting

1. Where test reporting is indicated, submit proof-of-design test reports for mass-produced equipment with the Shop Drawings.
2. Submit factory performance test reports for custom-manufactured equipment for approval prior to shipment.
3. Submit field test reports for review prior to Substantial Completion.

E. Remove and replace equipment or material that fails a test, or, if the ENGINEER approves, repair and retested for compliance.

F. Corrections to equipment or materials with a factory warranty shall be as recommended by the manufacturer and shall be performed in a manner that does not void the warranty.

1.9 DEMOLITION AND RELATED WORK

A. General

1. Perform electrical demolition WORK as indicated.
2. The CONTRACTOR is cautioned that demolition WORK may also be indicated on non-electrical Drawings.
3. Coordinate with all trades regarding electrical de-energization, disconnection, and removal, and the overall sequence of construction.

B. Electrical Requirements for Removed Equipment

1. Remove dedicated wiring and exposed conduits back to the source.
2. Abandon in place wiring that shares conduits with other equipment wiring, except power wiring.
3. Remove power wiring from the power source to the first pullbox or manhole remote from the panel, and abandon in place the remaining wiring.
4. Encased Conduits
   a. Abandon in place wiring routed through encased conduits.
   b. Cut encased conduits flush to the floor and grout flush with the floor.
5. Remove remote-mounted starters, disconnect switches, circuit breakers, sensors, and transmitters.

C. Where new lighting and receptacles are installed, remove old lighting, receptacles, switches, wiring, and conduits.

D. Junction Boxes

1. Wiring and conduits indicated to be extended shall be terminated in a new junction box with terminal strips.
2. Provide a junction box with a NEMA rating in accordance with the area in which it is located, and sized as required.
3. Properly identify wires and terminals before disconnection.

E. Removed materials and equipment not indicated to be returned to the OWNER shall, upon removal, become the CONTRACTOR'S property and shall be disposed of off- Site.

F. Identification

1. Where motor control centers, panelboards, etc. are indicated to have components, assemblies, or circuits removed and reconnected, provide the affected MCC compartments with new engraved nameplates worded as indicated and matching the existing, or modify the panelboard schedule to indicate the revised circuits.
2. Pencil or magic marker markings directly on the equipment or enclosures will not be accepted.

1.10 CONSTRUCTION SEQUENCING

A. General

1. Because the continuance of facility operation during the project is critical, the CONTRACTOR shall carefully examine the WORK to be provided in, on, or adjacent to existing equipment.
2. Schedule the WORK, subject to OWNER's approval, to minimize required shutdown time.
3. Submit a written sequencing request, including the sequence and duration of activities to be performed during plant shutdown.
4. Switching, safety tagging, and the like, as required for plant shutdown or to isolate existing equipment, shall be performed by the CONTRACTOR.
5. In no case shall the CONTRACTOR begin any WORK in, on, or adjacent to existing equipment without written authorization from the ENGINEER.

B. Modifications

1. Perform modifications or alterations to existing electrical facilities as required to successfully install and integrate the proposed electrical equipment as indicated.
2. Perform modifications to existing equipment, panels, and cabinets in a professional manner.
3. Repair coatings to match existing.
4. The costs for modifications to existing electrical facilities that are required for a complete and operating system shall be included as part of the WORK.

C. Existing Utilities

1. Exercise extreme caution when digging trenches to not damage existing underground utilities.
2. The cost of repairs of damages caused during construction shall be included as a part of the WORK.

D. Field Verifications

1. Visit the Site before submitting a Bid to become better acquainted with the WORK of this Contract.
2. The lack of knowledge will not be accepted as justification for extra compensation to perform the WORK.
3. The CONTRACTOR shall be responsible for identifying available existing circuit breakers in lighting panels for the intended use as required.
4. The CONTRACTOR shall be responsible for field verifying the available space in substation switchboards to integrate new power circuit breakers.
5. The cost for the above verifications shall be included as part of the WORK.

E. Installation of Temporary Equipment

1. To facilitate the continuous operation of existing equipment, provide the temporary equipment as indicated.

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2. Submit installation and connection details for review and acceptance by the ENGINEER.
3. Costs associated with these temporary installations shall be included as part of the WORK.
4. Temporary wiring and equipment shall remain the property of the CONTRACTOR unless indicated otherwise.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Provide equipment and materials that are new and are the products of experienced and reputable manufacturers in the industry.

B. Provide equipment and materials listed by UL and bearing the UL label, where UL requirements apply.

C. Provide similar items in the WORK as products of the same manufacturer.

D. Provide equipment and materials of industrial grade standard of construction.

E. Where a NEMA enclosure type is indicated in a non-hazardous location, use that type of enclosure despite the fact that certain modifications such as cutouts for control devices may negate the NEMA rating.

F. On devices indicated to display dates, display the year as 4 digits.

G. Temperature Ratings of Equipment Terminations.

1. Provide terminations and lugs rated for use with 75-degree C conductors.
2. Wire sizes in the Contract Documents are based on NEC ampacity tables using the 75-degree C ratings for circuits over 100 amps, or larger than #1 AWG.

2.2 MOUNTING HARDWARE

A. Miscellaneous Hardware

1. Provide nuts, bolts, and washers constructed of stainless steel.
2. Provide threaded rods for trapeze supports constructed from continuous threaded galvanized steel, 3/8-inch diameter minimum.
3. Struts
   a. Construct struts for mounting of conduits and equipment of galvanized steel.
   b. Where contact with concrete or dissimilar metals may cause galvanic corrosion, use suitable non-metallic insulators in order to prevent such corrosion.
   c. Strut Manufacturer, or Equal: **Unistrut**; **B-Line.**
4. End Caps
   a. Provide plastic protective end caps for all exposed strut ends.
   b. End Caps Manufacturer, or Equal: **Unistrut, Model P2860.**
5. Anchors

a. Provide stainless steel expansion anchors for attaching equipment to concrete walls, floors, and ceilings.

b. Wood plugs will not be accepted.

c. Anchor Manufacturer, or Equal: **"Power-Bolt"** or **"Power-Stud"** as manufactured by **Power Fasteners, Inc.**; similar by **Star**.

2.3 ELECTRICAL IDENTIFICATION

A. Nameplates

1. Fabricate nameplates from white-letter, black-face laminated plastic engraving stock, such as **Formica Type ES-1** or equal.

2. Securely fasten each nameplate, using fasteners constructed of brass, cadmium-plated steel, or stainless steel, and screwed into inserts or tapped holes as required.

3. Provide engraved characters of the block style, with no characters smaller than 1/4 inch top to bottom.

B. Conductor and Equipment Identification

1. Provide imprinted plastic-coated cloth marking devices, such as manufactured by Brady, Thomas & Betts, or equal.

2. Alternatively, provide heat-shrunk plastic tubing, imprinted split-sleeve markers cemented in place.

2.4 PROTECTIVE MATTING

A. Provide full-width, high-voltage switchboard matting in front of indoor switchboards, panelboards, service equipment, motor starters and control panels.

B. For 600-volt equipment, provide matting that is a minimum of 1/4 inch thick and 42 inches wide, or the full width of the aisle in front of the equipment if it is less than 42 inches.

C. Matting Manufacturer, or Equal

1. **W.H.Salisbury and Company; Mats, Inc.; Rhino**

PART 3 -- EXECUTION

3.1 GENERAL

A. Incidentals

1. Provide materials and incidentals required for a complete and operable system, even if not required explicitly by the Contract Documents.

2. 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

1. The Drawings diagrammatically indicate the desired location and arrangement of outlets, conduit runs, equipment, and other items.

2. 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.
3. Follow the locations on the Drawings, however, as closely as possible.
4. Conduits
    a. Where conduit development drawings or "home runs" are indicated, route the conduits in accordance with those requirements.
    b. Provide exposed or encased routings as indicated, except conceal conduit in finished areas unless indicated otherwise.
    c. Size conduits encased in a slab for conduit OD not to exceed 1/3 of the slab thickness, and lay out and space as to not impede concrete flow.
5. Placement
    a. Install conduit and equipment in such a manner as to avoid obstructions, to preserve headroom, and to keep openings and passageways clear.
    b. Locate luminaires, switches, convenience outlets, and similar items within finished rooms as indicated.
    c. Where exact locations are not indicated, such locations will be determined by the ENGINEER.
    d. If equipment is installed without instruction and must be moved, the cost of moving shall be included as part of the WORK.
    e. Slightly adjust luminaire locations in order to avoid obstructions and to minimize shadows.
6. Circuits
    a. Wherever conduits and wiring for lighting and receptacles are not indicated, it shall be the CONTRACTOR'S responsibility to provide lighting and receptacle-related conduits and wiring as required, based on the actual installed fixture layout and the circuit designations as indicated.
    b. Provide No. 12 AWG minimum wiring, and 3/4-inch minimum conduits (exposed) and one-inch minimum conduits (encased).
    c. Where circuits are combined in the same raceway, derate conductor ampacities in accordance with NEC requirements.

C. Workmanship
1. Install materials and equipment in strict accordance with the printed recommendations of the manufacturer, and using workers skilled in the WORK.
2. Coordinate installation in the field with other trades in order to avoid interferences.

D. Protection of Equipment and Materials
1. Fully protect materials and equipment against damage from any cause.
2. Cover materials and equipment, both in storage and during construction, in such a manner that no finished surfaces will be damaged, marred, or splattered with water, foam, plaster, or paint.
3. Keep moving parts clean and dry.

4. Replace or refinish damaged materials or equipment, including faceplates of panels and switchboard sections, as part of the WORK.

E. Provide incoming utility power equipment in conformance with the utility's requirements.

F. Provide raceways, wiring and appurtenances for the HVAC equipment in accordance with the equipment manufacturer’s recommendations.

3.2 CONCRETE HOUSEKEEPING PADS

A. Provide concrete housekeeping pads for floor-standing electrical equipment.

B. Extend housekeeping pads for equipment, including future units, 3-1/2 inches above the surrounding finished floor or grade, and one inch larger in both dimensions than the equipment, unless otherwise indicated.

C. Provide concrete housekeeping curbs for conduit stub-ups in locations that are not concealed by equipment enclosures.

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.

B. Provide wall-mounted panels that weigh more than 100 pounds or that are within 18 inches of the floor with fabricated steel support pedestals.

C. If the supported equipment is a panel or cabinet enclosed within removable side plates, match supported equipment in physical appearance and dimensions.

D. Provide transformers hung from 4-inch stud walls and weighing more than 100 pounds with auxiliary floor supports.

E. Manufacturer's Recommendations

1. Anchoring methods and leveling criteria in the printed recommendations of the equipment manufacturers are a part of the WORK of this Contract.

2. Submit such recommendations as Shop Drawings as indicated.

3.4 EQUIPMENT IDENTIFICATION

A. Provide nameplates for panelboards, control and instrumentation panels, starters, switches, and pushbutton stations.

B. In addition to nameplates, equip control devices with standard collar-type legend plates.

C. Identify control devices within enclosures as indicated and similar to the subparagraph above.

D. Provide suitable inscribed finish plates for toggle switches that control loads out of sight of switches and for multi-switch locations of more than 2 switches.

E. Use equipment names and tag numbers, where indicated, on nameplates.

F. Provide typewritten circuit directories for panelboards, that accurately reflect the outlets connected to each circuit.

G. Terminal Blocks

1. Label termination points on terminal blocks by identifiers on the blocks.

2. Provide identifiers that have been preprinted by the terminal manufacturer or custom-printed.
3. Hand-lettered markers will not be accepted.

H. Tag distribution equipment, stand-alone disconnects, starters, and VFDs with appropriate arc-flash labels.

3.5 CLEANING

A. Before final acceptance, thoroughly clean the electrical WORK of cement, plaster, and other materials.

B. Remove temporary tags, markers, stickers, and the like.

C. Remove oil and grease spots with a non-flammable cleaning solvent, by carefully wiping and scraping cracks and corners.

D. Apply touch-up paint to scratches on panels and cabinets.

E. Vacuum-clean electrical cabinets and enclosures.

F. Clean luminaires inside and out.

G. Dispose cleaning debris and refuse off-Site.

END OF SECTION

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SECTION 26 01 26 – ELECTRICAL TESTS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. This Section specifies the WORK necessary to test, commission, and demonstrate that the electrical work satisfies the criteria of these Specifications and functions as required by the Contract Documents.

B. The WORK of this Section includes furnishing the labor, equipment, and power required to support the testing indicated in other Divisions of these Specifications. Electrical testing indicated herein and functional testing of power and controls not tested under other Divisions, shall be completed before commencement of the 7 Day test of Section 01 75 00 - Equipment Testing and Startup. This scope may require the CONTRACTOR to activate circuits, shutdown circuits, run equipment, make electrical measurements, replace blown fuses, and install temporary jumpers, etc.

C. The requirements of Section 26 00 00 - Electrical Work, General, apply to the WORK of this Section.

D. Carry out tests indicated herein for individual items of materials and equipment in other Sections. Testing shall be done in accordance with the manufacturer's instructions, these Specifications, and applicable NETA Acceptance Testing Specifications, NEMA, ANSI, NFPA, and ASTM Standards.

1.2 REFERENCES

A. General

1. The publications listed below form a part of this specification to the extent referenced.

2. Where a date is given for reference standards, the edition of that date shall be used. Where no date is given for reference standards, the latest edition available on the date of the Notice Inviting Bids shall be used.

B. American National Standards Institute (ANSI)

C. Institute of Electrical and Electronics Engineers, Inc. (IEEE)

D. IEEE 576, Recommended Practice for Installation, Termination, and Testing of Insulated Power Cable as Used in Industrial and Commercial Applications

E. InterNational Electrical Testing Association (NETA)

F. NFPA 70, National Electrical Code (NEC)

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 00, Contractor Submittals.

B. Submit complete system test procedures for review. Test procedures shall include but not be limited to:

1. Detailed procedures in sufficient detail to verify conformance with these Specifications.

2. Incorporation of the Test Record Sheets included at the end of this Section.

3. Detailed comprehensive testing schedule including:

a. Each major piece of electrical distribution equipment.

b. Each major electrical subsystem.

c. Duration of each test.

d. Milestone test completion date.

e. Ambient Conditions at time of test

f. Date of test results submittals following completion of the tests.

g. Names and qualifications of the individual(s) responsible for performing the testing.

C. Following completion of the test submit the completed test results to the Engineer for review. The results shall include a dedicated section with the “as-left” settings of all devices, relays, circuit breakers, etc.

D. Test result shall be submitted in one submittal

E. Test reports shall be based on NETA’s latest Acceptance Testing Specifications having a sign-off, pass/fail data filed for each line item covered by NETA’s Acceptance Testing Specifications latest edition.

1.4 COMMISSIONING

A. Commissioning during the 7 Day test in Section 01 75 00 shall not be attempted until all subsystems have been found to operate satisfactorily. Commissioning shall only be attempted as a function of normal plant operation.

B. Motor Current Tabulation

1. Motors 5HP and larger which have current/power measurement capabilities shall have this phase voltage, phase amperage, total power and power factor data recorded every 5 minutes while operating during commissioning.

PART 2 -- TESTING & REPORTS

2.1 PRE-ENERGIZATION AND OPERATING TESTS

A. The complete electrical system shall be performance tested when first installed on-site. Each protective, switching, and control circuit shall be adjusted in accordance with the recommendations of the protective device study and tested by actual operation using

current injection or equivalent methods as necessary to ensure that each and every such circuit operates correctly to the satisfaction of the authority having jurisdiction.

1. Switching Circuits. Each switching circuit shall be observed to operate the associated equipment being switched.

2. Control and Signal Circuits. Each control or signal circuit shall be observed to perform its proper control function or produce a correct signal output.

3. Acceptance Tests. Complete acceptance tests shall be performed, after the station installation is completed, on all assemblies, equipment, conductors, and control and protective systems, as applicable, to verify the integrity of all the systems.

B. Test Report. A test report covering the results of the tests required in the **Pre-Energization and Operating Tests** shall be delivered to the authority having jurisdiction prior to energization. Acceptance Testing shall be in accordance with NETA ATS-2009, *Electrical Power Distribution Equipment and Systems*, published by the InterNational Electrical Testing Association.

2.2 TEST REQUIREMENTS

A. The following test requirements supplement test and acceptance criteria that may be stated elsewhere.

1. Lighting: Switching, include remote control, if present in system. Circuitry is in accordance with panel schedules. All interior and exterior lighting shall be checked for proper operation.

2. Power Instrumentation: Demonstrate that voltage and ampere metering are functional and reading correctly.

3. Demonstrate mechanical and/or electrical interlocking by attempting to subvert the intended sequence.

4. Activate ground fault tripping of GFCI receptacles with a plg-in device designed for that purpose.

5. Low Voltage Cables-600 volts Maximum

   a. Visual and Mechanical Inspection

      1) Compare cable data with drawings and specifications.

      2) Inspect exposed sections of cables for physical damage and correct connection in accordance with single-line diagram.

      3) Inspect bolted electrical connections for high resistance using one of the following methods:

         a) Use of low-resistance ohmmeter.

         b) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS- 2009, Table 100.12.

4) Inspect compression-applied connectors for correct cable match and indentation.

5) Inspect for correct identification and arrangements.

6) Inspect cable jacket insulation and condition.

b. Electrical Tests

1) Perform insulation-resistance test on each conductor with respect to ground and adjacent conductors. Applied potential shall be 500 volts dc for 300 volt rated cable and 1000 volts dc for 600 volt rated cable. Test duration shall be one minute.

a) Motor feeders tested with motors disconnected and controller open.

b) Motor control circuits tested and verified for proper operation with control stations and overcurrent devices connected.

c) Panelboard feeders tested with feeder breaker open and panel-board connected. If a lighting transformer is associated with the panelboard, it shall be connected and the test made for both primary and secondary sides.

d) Conductors of main lighting feeders, including lighting panel with branch circuits open.

e) Prior to performing insulation resistance tests on cables, verify that they are not connected to a solid state device.

f) Equipment which may be damaged during this test shall be disconnected.

g) The Engineer shall be consulted if minimum insulation values cannot be obtained.

2) Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.

3) Perform continuity test to insure correct cable connection.

c. Test Values – Visual and Mechanical

1) Compare bolted connection resistance to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

2) Bolt-torque levels should be in accordance with NETA ATS-2009, Table 100.12 unless otherwise specified by the manufacturer.

d. Test Values – Electrical

1) Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

2) Insulation-resistance values shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS-2009 Table 100.1. Values of insulation resistance less than this table or manufacturer's recommendations shall be investigated.

3) Cable shall exhibit continuity.

4) Deviations in resistance between parallel conductors shall be investigated.

6. Test ground interrupter (GFI) receptacles and circuit breakers for proper operation by methods sanctioned by the receptacle manufacturer.

7. A functional test and check of 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:

   a. Visual and physical check of cables, circuit breakers, transformers, and connections associated with each item of new and modified equipment.

   b. Verification that electrical equipment has been labeled with Arc Flash protection boundary and PPE levels in accordance with the NEC., and as required by Section 260573 – Protective Device Studies.

   c. Setting of protective relays in conformance with results of the Short Circuit Study required by Section 260573 - Protective Device Studies and testing of relays to assure that relays will trip at the current value and time required by the Study.

   d. Circuit Breakers

      1) 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.

      2) Time and pickup setting shall correspond to the recommendations of the Short Circuit Study, load equipment manufacturers and Code.

      3) Setting shall be tabulated and proven for each circuit breaker in its installed position.

      4) Test results shall be certified by the person performing the tests and shall be submitted to the ENGINEER.

8. Complete ground testing of grounding electrodes per requirements below prior to operating the equipment.

B. 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. Alarm conditions shall be

simulated for each alarm point, and alarm indicators shall be checked for proper operation. 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.

C. Metering and indication lights for motors and other devices shall be tested for proper operation.

D. All control circuits such as motor, interlock and remote shall be tested for proper operation.

E. 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.

F. Motor operated valves and gates shall be tested after having been phased and tested for correct motor rotation and after travel and torque limit switches have been adjusted by a representative of the valve or gate manufacturer. Tests shall verify status indication, proper valve travel, and correct command control from local and remote devices.

G. All lighting panels, circuits and fixtures; and power panels, circuits and receptacles shall be tested for proper operation.

H. Provide ground resistance tests on the main grounding electrode or system in the presence of the ENGINEER and submit results

1. Visual and Mechanical Inspection

    a. Verify ground system is in compliance with drawings and specifications.

2. Electrical Tests

    a. Perform fall-of-potential test or alternative in accordance with IEEE Standard 81 on the main grounding electrode or system.

    b. The earth resistance of each ground electrode shall be measured and recorded before electrodes are connected to the grounding loop.

    c. Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and/or derived neutral points.

3. Test Values

    a. The resistance between the main grounding electrode and ground shall be no greater than five ohms for commercial or industrial systems and one ohm or less for generating or transmission station grounds unless otherwise specified by the owner.

    b. Investigate point-to-point resistance values which exceed 0.5 ohm.

I. Subsystems shall be defined as individual and groups of pumps, conveyor systems, chemical feeders, air conditioning units, ventilation fans, air compressors, etc.

2.3 TEST REPORTS

A. The test report shall include the following:

1. Summary of project.
2. Description of equipment tested.
3. Description of test.
4. Test data.
5. Analysis and recommendations.

B. Test data records shall include the following minimum requirements:

1. Identification of the testing organization.
2. Equipment identification.
3. Humidity, temperature, and other atmospheric conditions that may affect the results of the tests/calibrations.
4. Date of inspections, tests, maintenance, and/or calibrations.
5. Identification of the testing technician.
6. Indication of inspections, tests, maintenance, and/or calibrations to be performed and recorded.
7. Indication of expected results when calibrations are to be performed.
8. Indication of “as-found” and “as-left” results.
9. Sufficient spaces to allow all results and comments to be indicated.

C. The testing firm shall furnish a copy or copies of the complete report to the owner as required in the acceptance contract.

PART 3 -- TEST RECORD SHEETS

The test record sheets listed below shall be used to record testing of electrical equipment and of the electrical installation as required by these specifications. Sample copies of each sheet are attached.

Sheet No.	Title
1	Insulation Resistance (Power, Control Wire, and Cable) Test Record
2	Insulation Resistance (Instrument Wire and Cable) Test Record
3	DC High Potential (Medium Voltage Cable) Test Record
4	Ground Electrode Testing Test Record
6	Bonding Resistance Readings (Nonelectrical Equipment/Structures) Test Record
7	Bonding Resistance Readings (Electrical Equipment) Test Record
8	Insulation Resistance (Transformer) Test Record
9	Insulation Resistance (Equipment) Test Record
12	Record Feeder Breaker (480 VAC) Test Record
13	Breaker/Contactor (480 VAC) Test Record
14	460 VAC Motor Circuit (480 VAC) Test Record
16	Electric Motor Run-In Test Record

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INSULATION RESISTANCE
(POWER, CONTROL WIRE, AND CABLE)
TEST RECORD

TEST EQUIPMENT: _____ TEST VOLTAGE: _____

TEST EQUIPMENT: _____ TEST VOLTAGE: _____

AMBIENT TEMPERATURE: _____ ºC _____ ºF DATE: _____

NOTES:
1. Perform Insulation Resistance Test (megger) between each conductor and all other conductors and metallic sheath for cables with nonshielded conductors. Test between each conductor and shield for multiconductor cables with shielded conductors. Record lowest reading for each cable.
2. Use 1,000-V test set for cable rated 600 volts and 2,500-V test set for cable rated over 600 volts.
3. Readings will vary inversely with temperature and cable length. When the use of temperature correction factors is specified, attach a second sheet with computed values. Indicate on each sheet “measured” or “temperature corrected.”

Panel No. Circuit No. Feeder No.	Wire Tagging	Cable Rated Voltage	Wire or Cable				Insulation Resistance (megohms) *	Initials
			Quantity	Size	From	To		

*Minimum acceptable values:

Cable Rated Voltage	Test Duration	Resistance for Cable Only	Cable/Wire Size or Amperage (megohms)	Resistance When Cable Connected to Equipment (ohms)

DISTRIBUTION:

CONTRACTOR/Date _____

INSULATION RESISTANCE
(INSTRUMENT WIRE AND CABLE)
TEST RECORD

TEST EQUIPMENT: _____ TEST VOLTAGE: _____

TEST EQUIPMENT: _____ TEST VOLTAGE: _____

AMBIENT TEMPERATURE: _____ ºC _____ ºF DATE: _____

NOTES: 1. Record only the lowest value.

2. MP - Multi-pair cable. SP - Single pair cable.
3. Megger with instruments disconnected.
4. Use 250 volt (or lower voltage, when specified) range on DC test set.
5. Readings will vary with temperature and cable length.*

Cable Number or Instrument Number	Indicate MP or SP Type (2)	Conductor to Conduit (Single Pair Non-Shielded Cables) (megohms)	Conductor to Conductor (megohms) (1)	Shield to Conductor to Shield (megohms) (1)	Overall Shield to Shield (Multipair Cables Only) (megohms) (1)	Lead and Armor (Multipair Cables Only (megohms)	Shield to Conduit (Single Pair Cables Only) (megohms)	Initials

DISTRIBUTION:

CONTRACTOR/Date _____

DC HIGH POTENTIAL (MEDIUM VOLTAGE CABLE)
TEST RECORD

CIRCUIT NUMBER: _____

CABLE SIZE: _____ (SQ.MM.) _____ (MCM)

NUMBER OF CONDUCTORS: _____

CABLE LENGTH: _____

INSULATION TYPE: _____

WEATHER: _____

TEMP.: _____ °C _____ °F

REF. DWG.: _____

FROM: _ TO: _____

NO. OF SPLICES: _____

MANUFACTURER: _____

THICKNESS: _____

JACKET MATERIAL: _____

% HUMIDITY: _____

DATE: _____

TEST EQUIPMENT USED: _____

NOTES:
1. The test voltage shown below shall be reached in 10 equal voltage increments.
2. After each voltage increase, the leakage current shall be allowed to stabilize during a 1-minute interval. If 1-minute intervals are insufficient to stabilize the current, the cable shall be discharged, and the test repeated with new time intervals of greater, but still equal duration.
3. Record the stabilized leakage current, in microamps, at the end of each time interval.
4. Allow the voltage to remain constant at the full test voltage and record the leakage current for 5 minutes for unshielded cables and 15 minutes for shielded cables.
5. Read test equipment instruction manual prior to testing cable.
6. When the plotting of test results is specified, attach the second sheet with separate plot for each phase. Note leakage current, in microamps, on “y” axis. Note step-voltage increase on “x” axis, followed by time, in minutes, for the dielectric absorption portion of the test.
7. All other phases and shields to be grounded.

Voltage hold time at each step _____ sec.	____k V	____k V	____k V	____k V	____k V	____k V	____k V	____k V	____k V	____k V
ØA[7]										
ØB[7]										
ØC[7]										

RECORD LEAKAGE CURRENT IN MICROAMPS

Time at _____ Kv	SEC 30	MIN 1	MIN 2	MIN 3	MIN 4	MIN 5	MIN 6	MIN 7	MIN 8	MIN 9	MIN 10	MIN 11	MIN 12	MIN 13	MIN 14	MIN 15

CABLE-RATED VOLTAGE
(kilovolts)

TEST VOLTAGE
(kilovolts)

DISTRIBUTION:

CONTRACTOR/Date _____

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GROUND ELECTRODE TESTING
TEST RECORD

TEST EQUIPMENT: _____ (Note 1) _____ (Note 2)

REFERENCE DRAWING: _____ _____

NOTES: 1. Record resistance-to-earth for each electrode with all other conductors disconnected. Resistance not to exceed 25 ohms for any single anode.

8. Check continuity from each electrode to any test bar or other electrode such that the complete ground loop is tested.

Rod Number	Resistance to Earth (ohms)	Ambient Temperature (ºC/ºF)	Weather	Taps (□)	Initials/Date

DISTRIBUTION:

CONTRACTOR/Date _____

BONDING RESISTANCE READINGS
(NONELECTRICAL EQUIPMENT/STRUCTURES)
TEST RECORD

TEST EQUIPMENT USED: _____ WEATHER: _____

NOTES: 1. Vessels, tanks, and structural steel bonded to the main grounding system, dedicated ground rod or foundation, as indicated on drawings listed below.

2. Measure resistance from ground wire tap (or anchor bolt) to tagged equipment frame or structural steel.

EQUIPMENT TAG NO. OR STRUCTURE	DRAWING	MEASURED RESISTANCE (ohms)	INITIALS/DATE

DISTRIBUTION:

CONTRACTOR/Date _____

BONDING RESISTANCE READINGS
(ELECTRICAL EQUIPMENT)
TEST RECORD

TEST EQUIPMENT USED: _____ WEATHER: _____

NOTES: 1. Electrical equipment bonded to the main grounding system or dedicated ground rod, as indicated on drawings listed below.

2. Measure resistance from ground wire tap to tagged equipment bus bars, tagged equipment enclosures, and any other points indicated on the drawings.

EQUIPMENT TAG NO. OR STRUCTURE	DRAWING	MEASURED RESISTANCE (ohms)	INITIALS/DATE

DISTRIBUTION:

CONTRACTOR/Date _____

INSULATION RESISTANCE
(TRANSFORMER)
TEST RECORD

SUBSTATION NO.: _____ TEST EQUIPMENT: _____

NOTES:
1. Use 1,000-V test set for 600-volt equipment and below, 2,500-V test set for equipment rated 601 - 5,000 volts, and 5,000-V test set for equipment rated over 5,000 volts.
2. Test voltage to be applied for 1-minute duration, and reading taken.
3. Neutral must be disconnected from ground during test.
4. Record temperature of surrounding air temperature for dry-type transformers.
5. Readings will vary inversely with temperature. When the use of temperature correction factors is specified, attach second sheet with computed values. Indicate on each sheet "measured" or "temperature corrected."

Equipment Tag No.	RESISTANCE IN (megaohms) *						Pri to Sec	Voltage Rating (kV)	Pri-Sec or Air	Liquid Temp. (ºC/ºF)
	Primary			Secondary						
	∅A to G	∅B to G	∅C to G	∅A to G	∅B to G	∅C to G				

*Minimum acceptable values:

VOLTAGE CLASS	RESISTANCE (megohms)

TESTER'S INITIALS/DATE

_____

DISTRIBUTION:

CONTRACTOR/Date _____

INSULATION RESISTANCE (EQUIPMENT)
TEST RECORD

TEST EQUIPMENT: _____ SUBSTATION: _____

AMBIENT TEMPERATURE: _____ ºC _____ ºF DATE: _____

REFERENCE DRAWING: _____ REF. SEC.: _____

NOTES: 1. Use 1,000-V test set for equipment rated 600 volts and below, 2,500/5,000-V test set for equipment rated over 600 volts.

2. For equipment with solid state control circuits, consult manufacturer's literature for maximum test voltages.

Switchgear MCC (other)	INSULATION RESISTANCE (megohms) *						Test Voltage (kV)	Rated Voltage (kV)	Initials/ Date
	∅A to G	∅B to G	∅C to G	∅A to ∅B	∅B to ∅C	∅C to ∅A			

*Minimum acceptable values:

EQUIPMENT VOLTAGE CLASS (megohms)	RESISTANCE

TESTER'S INITIALS/DATE

_____

DISTRIBUTION:

CONTRACTOR/Date _____

FEEDER BREAKER (480 V MCC)
TEST RECORD

EQUIPMENT DESIGNATION		
LOAD (kW/kVA)	VOLTAGE	F.L.A.
CIRCUIT BREAKER MFG.	RATING	SETTING
CONDUCTOR SIZE POWER	GROUND	

1. Check nameplate data of breaker against approved vendor drawings. _____
2. Check breaker components for cleanliness. _____
3. Check mechanical function of breaker. _____
4. Check wiring for proper identification. _____
5. Check conduits/cables for tagging. _____
6. Check components for identification. _____
7. Check equipment for conformance of area classification. _____
8. Check installation for seals, breathers, and drains. _____
9. Verify power conductor continuity. _____
10. Check that power cable insulation resistance test (megger) is completed. _____

DISTRIBUTION:

CONTRACTOR/Date _____

BREAKER/CONTACTOR (480 V MCC)
TEST RECORD

	EQUIPMENT DESIGNATION
LOAD (kW/kVA)	VOLTAGE F.L.A.
CIRCUIT BREAKER MFG.	RATING SETTING
CONTACTOR MFG.	SIZE
CONDUCTOR SIZE POWER	CONTROL GROUND

1. Check nameplate data of breaker, contactor fuses and relays against approved vendor drawings. _____
2. Check main and auxiliary contacts. _____
3. Check contactor/breaker components for cleanliness. _____
4. Check control fuses, CPT rating, and coil voltage. _____
5. Check mechanical function of contactor and breaker. _____
6. Check wiring for proper identification. _____
7. Check conduits/cables for tagging. _____
8. Check components for identification. _____
9. Check equipment for conformance to area classification. _____
10. Check installation for seals, breathers, and drains. _____
11. Verify continuity of all power and control leads. _____
12. Check that power and control cable Insulation Resistance Test (megger) is completed. _____
13. Complete functional operation check of the control circuit using contract drawings and approved vendor drawings. Close and open the contactor using all control devices. _____

DISTRIBUTION:

CONTRACTOR/Date _____

460 V MOTOR CIRCUIT (480 V MCC)
TEST RECORD

EQUIPMENT DESIGNATION		
MOTOR TAG NO.	VOLTAGE	F.L.A.
KW/HP	RPM	S.F.
CIRCUIT BREAKER MFG.	RATING	SETTING
STARTER MFG.	SIZE	O/L HTR. SIZE
C.T. RATIO	O/L RELAY SETTING	
CONDUCTOR SIZE POWER	GROUND	

1. Check motor starter for cleanliness. _____

2. Check nameplate data and tagging of motor starter components for conformance to approved vendor drawings. _____

3. Check conduits and/or cables for correct tagging. _____

4. Check equipment and installation for conformance to area classification. _____

5. Check main and auxiliary contacts of breaker and contactors. _____

6. Manually check mechanical operation of breaker, contactor, O/L relay, and O/L reset device. _____

7. Check continuity of power and control cables. _____

8. Complete functional operation check of the motor control circuit using the contract drawings and approved vendor drawings. Close and open the starter using all control devices. _____

9. Verify proper operation of motor winding space heater unit. _____

DISTRIBUTION:

CONTRACTOR/Date _____

ELECTRIC MOTOR RUN-IN
TEST RECORD

TEST EQUIPMENT: _____ REFERENCE DRAWING: _____

NOTES: 1. Duration of tests to comply with specifications.

TEST	REMARKS	INITIALS/DATE
RESISTANCE: Bonding resistance measured from motor frame to main ground/earth system tap. _____ ohms		
VOLTAGE: Actual voltage measured at Motor Control Center. _____ volts		
ROTATION CHECK: Bump motor to verify rotation. Motor to be uncoupled.		
NO LOAD CURRENT: At beginning of test _____ amps At end of test _____ amps		
TEMPERATURE OF BEARING: Check bearing for high temperature: Before start: 15 minutes after start 30 minutes after start 1 hour after start 2 hours after start 3 hours after start		
VIBRATION: Make visual inspection during run-test. Record any unusual vibration in remarks column.		
NOISE: Record any unusual noise in remarks column.		

DISTRIBUTION:

CONTRACTOR/Date _____

END OF SECTION

SECTION 26 05 10 - ELECTRIC MOTORS

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. General**:** The CONTRACTOR shall provide electric motors, accessories, and appurtenances complete and operable, in conformance to the Contract Documents.

B. The provisions of this Section apply to low voltage 3 phase, AC squirrel cage induction motors throughout the Contract Documents, except as indicated otherwise.

C. The CONTRACTOR shall assign to the equipment supplier the responsibility to select suitable electric motors for the equipment. The choice of motor manufacturer shall be subject to review by the ENGINEER. Such review will consider future availability of replacement parts and compatibility with driven equipment.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Contractor Submittals.

B. Complete motor data shall be submitted with the driven machinery Shop Drawings. Motor data shall include:

1. Machine name and specification number of driven machine.
2. Motor manufacturer.
3. Motor type or model and dimension drawing. Include motor weight.
4. Nominal horsepower.
5. NEMA design.
6. Enclosure.
7. Frame size.
8. Winding insulation class and temperature rise class.
9. Voltage, phase, and frequency ratings.
10. Service factor.
11. Full load current at rated horsepower for application voltage.
12. Full load speed.
13. Guaranteed minimum full load efficiency. Also, nominal efficiencies at 1/2 and 3/4 load.
14. Type of thermal protection or overtemperature protection, if included
15. Wiring diagram for devices such as motor leak detection, temperature, or zero speed switches, as applicable
16. Bearing data. Include recommendation for lubricants of relubricatable type bearings.

17. If utilized with a variable frequency controller, verify motor is inverter duty type. Include minimum speed at which motor may be operated for the driven machinery. Provide shaft grounding details and information.
18. Power factor at 1/2, 3/4 and full load.
19. Information on all accessories provided.

PART 2 -- PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Electric motors driving identical machines shall be identical.

B. Maximum motor loading shall be equal to nameplate horsepower rating or less, exclusive of service factor and be verifiable from the submittal data of the driven machinery.

C. Motor Capacity

1. The CONTRACTOR shall size motors for the larger of the following criteria:

a. Size motors to continuously carry the maximum load that develops across the full range of driven equipment operation.

b. Size motors for minimum size indicated.

2. In every case, motor size shall be derated from nameplate values as follows:

a. Ambient Temperature

1) For ambient temperatures up to but not exceeding 40 degrees C, no derating is required.

2) For ambient temperatures exceeding 40 degrees but less than 50 degrees C, derate nameplate HP ratings to 85 percent.

b. Site Altitude: No derating is required for altitudes less than 3300 feet (1000 meters). Higher altitudes require the following derating factors:

Altitude	1.0 Service Factor	1.15 Service Factor
3300 to 9000 ft	93 percent	100 percent
9000 to 13,200 ft	91 percent	98 percent

3. Increased circuit breaker, magnetic starter, and conductor and conduit capacities required for motors larger than the indicated sizes shall be provided as part of the WORK.

D. Exempt Motors: Motors for valve and gate operators, submersible pumps, or motors which are an integral part of standard manufactured equipment, i.e., non-NEMA mounting,

common shaft with driven element, or part of domestic or commercial use apparatus may be excepted from these requirements to the extent that such variation reflects a necessary condition of motor service or a requirement of the driven equipment.

2.2 DESIGN REQUIREMENTS

A. General: Electric motors shall comply with NEMA MG-1 - Motor and Generator. Motors used with adjustable frequency drives shall comply with NEMA MG-1, Part 31, and shall be clearly identified as “Inverter Duty.”

B. NEMA Design: Electric motors shall be NEMA Design B unless otherwise indicated. In no case shall starting torque or breakdown torque be less than the value in NEMA MG 1. Motors shall be suitable for the indicated starting method.

C. Motor Voltage Ratings: Low voltage motors shall have voltage ratings in accordance with the following, unless otherwise indicated:

1. Motors below 1/2 HP shall be rated 115 volts, single phase, 60 Hz. Dual voltage motors rated 115/230 volts, 115/208 volts, or 120-240 volts are acceptable, provided leads are brought out to the conduit box.

2. Motors 1/2 HP and larger shall be rated 460 volts, 3 phase, 60 Hz. Dual voltage motors rated 230/460 volts, or 208/230/460 volts are acceptable, provided every lead is brought out to the conduit box.

D. Insulation: Three phase motors shall be provided with Class F insulation, rated to operate at a maximum ambient temperature of 40 degrees C and at the altitudes where the motors will be installed and operated, without exceeding Class B temperature rise limits stated in NEMA MG 1-12.44. Single phase motors shall have Class F insulation with temperature rise not to exceed the insulation class. Motors to be operated from adjustable frequency drives shall be provided with insulation systems to withstand 1600-volt spikes, with dV/dT as defined in NEMA MG 1-31. The adjustable frequency drive manufacturer shall coordinate with the motor manufacturer to determine when additional dV/dT protection is required. Where required, it shall be furnished and installed as per the manufacturer’s written instructions.

E. Motors 50 HP or smaller shall be totally enclosed, fan cooled (TEFC) with a Service Factor of 1.15 unless otherwise indicated.

F. Motors 50 HP and greater TEFC, with a service factor of 1.15.

G. Motors larger than 1/2 HP installed outdoors shall be provided with 120 volt AC space heaters, wired to a terminal strip in a low voltage motor junction box. If provided by the manufacturer when not specified, the CONTRACTOR shall connect them at no extra cost to the OWNER, in order to keep the warranty in force.

H. NEMA Premium Efficiency Motors

1. Motors with a nameplate rating of 1 HP and larger shall be NEMA premium efficient units. Motors shall be stamped with the efficiency on the nameplate with the caption "NEMA Nominal Efficiency" or "NEMA Nom. Eff." Such motors shall have efficiencies determined by the test as set forth in ANSI/IEEE 112 - Standard Test Procedure for Polyphase Induction Motors and Generators, Method B.

2. Efficiency: Nominal efficiency and minimum efficiency shall be defined in accordance with the following tables. Both efficiencies shall be included in the Shop Drawing submittal.

TOTALLY ENCLOSED - FAN COOLED (TEFC)						
FULL-LOAD EFFICIENCIES OF NEMA PREMIUM EFFICIENCY MOTORS RATED 600 VOLTS OR LESS						
	2 POLE		4 POLE		6 POLE	
HP	Nom. Effic.	Min. Effic.	Nom. Effic.	Min. Effic.	Nom. Effic.	Min. Effic.
1	77.0	74.0	85.5	82.5	82.5	80.0
1.5	84.0	81.5	86.5	84.0	87.5	85.5
2	85.5	82.5	86.5	84.0	88.5	86.5
3	86.5	84.0	89.5	87.5	89.5	87.5
5	88.5	86.5	89.5	87.5	89.5	87.5
7.5	89.5	87.5	91.7	90.2	91.0	89.5
10	90.2	88.5	91.7	90.2	91.0	89.5
15	91.0	89.5	92.4	91.0	91.7	90.2
20	91.0	89.5	93.0	91.7	91.7	90.2
25	91.7	90.2	93.6	92.4	93.0	91.7
30	91.7	90.2	93.6	92.4	93.0	91.7
40	92.4	91.0	94.1	93.0	94.1	93.0
50	93.0	91.7	94.5	93.6	94.1	93.0
60	93.6	92.4	95.0	94.1	94.5	93.6
75	93.6	92.4	95.4	94.5	94.5	93.6
100	94.1	93.0	95.4	94.5	95.0	94.1
125	95.0	94.1	95.4	94.5	95.0	94.1
150	95.0	94.1	95.8	95.0	95.8	95.0

Source: NEMA MG1 - 2011, Table 12-12

2.3 ACCESSORY REQUIREMENTS

A. General: Horizontal motors 3 HP and larger and every vertical motor shall have split-type cast metal conduit boxes. Motors shall be provided with oversized conduit boxes. Motors other than open drip-proof shall be gasketed.

B. Lifting Devices: Motors weighing 265 lb (120 Kg) or more shall have suitable lifting eyes for installation and removal.

C. Special Requirements: The CONTRACTOR shall refer to individual equipment specifications for special requirements such as motor winding thermal protection or multi-speed windings.

D. Grounding Lugs: Provide motor grounding lug suitable to terminate ground wire, sized as indicated.

E. Nameplate: Motors shall be fitted with permanent stainless-steel nameplates indelibly stamped or engraved with NEMA Standard motor data, in conformance with NEMA MG-1-10.40. Inverter duty motors shall be clearly identified as such.

F. Where motors are indicated by elementary schematics or specifications to have accessories, the accessories shall be factory mounted integral to the motors.

G. Inverter duty motors shall be provided with shaft grounding rings. Rings shall be factory installed, and shall be by Aegis, or equal. The motor warranty shall include coverage against VFD-induced bearing damage or failure. Inverter duty motors shall be provided with insulated bearing(s) when recommended by the motor manufacturer.

2.4 MOTOR THERMAL PROTECTION

A. Single Phase Motors: Single phase 120, 208-volt motors shall have integral thermal overload protection or shall be inherently current limited.

B. Thermostats: Where indicated or specified, winding thermostats shall be snap action, bi-metallic, temperature-actuated switch. Thermostats shall be provided with one normally closed contact. The thermostat switch point shall be precalibrated by the manufacturer. All inverter duty motors shall be provided with winding thermostats.

2.5 MOTOR BEARINGS

A. General: Bearings shall conform to Section 46 01 00 - Equipment General Provisions, except as indicated herein.

B. Motors greater than 2 HP shall have bearings designed for 17,500 hours (belted) or 100,000 hours (coupled) L-10 life.

C. Fractional Horsepower: Motors with fractional horsepower through 2 HP shall be provided with lubricated-for-life ball bearings.

D. Horizontal Motors Over 2 HP: Motors larger than 2 HP shall be provided with relubricatable ball bearings. Lubrication shall be per manufacturer's recommendation for smooth operation and long life of the bearings.

E. Vertical Motors Over 2 HP: Vertical motors larger than 2 HP shall be provided with relubricatable ball, spherical, roller, or plate type thrust bearings. Lubrication shall be per manufacturer's recommendation for smooth operation and long life of the bearings.

F. Inverter Duty Motors: Provide an insulated bearing to prevent circulating bearing currents.

2.6 MANUFACTURERS, OR EQUAL

A. U.S. Motors

B. General Electric

C. WEG

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Motor installation shall be performed in accordance with the motor manufacturer's written recommendations and the written requirements of the manufacturer of the driven equipment. Shaft grounding devices shall be connected to the grounding system in accordance with the manufacturer’s recommendations.

B. Related electrical WORK involving connections, controls, switches, and disconnects shall be performed in accordance with the applicable sections of Division 26.

3.2 FIELD TESTING

A. The CONTRACTOR shall perform the following field tests:

1. Inspect each motor installation for any deviation from rated voltage, phase, frequency, and improper installation.

2. Visually check for proper phase and ground connections. Verify that multi-voltage motors are connected for proper voltage. Verify shaft grounding devices are properly grounded.

3. Check winding and bearing temperature detectors and space heaters for functional operation.

4. Test for proper rotation prior to connection to the driven equipment.

5. Visually check that motor overload heaters are properly sized and that MCP breaker settings are correct for the motor installed.

6. Test insulation (megger test) of new and re-used motors in accordance with NEMA MG-1. Test voltage shall be 1,000 VAC plus twice the rated voltage of the motor.

END OF SECTION

SECTION 26 05 15 – INDUSTRIAL CONTROL PANELS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide complete industrial control panels and/or local control stations as indicated herein or in other Sections of the Specifications. The stations shall be designed to provide the sequence of operation in Contract Documents.

B. This section also specifies miscellaneous electrical devices used throughout this project. These devices are not limited to use within industrial control panels or local control stations.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Industrial control panels and/or local control stations shall comply with THE SUMMARYs of NEC (including Article 409), NEMA, and UL.

1.3 CONTRACTOR SUBMITTALS

A. Furnish Shop Drawings in accordance with Sections 01 33 00 – Contractor Submittals and 26 00 00 – Electrical Work, General.

1. Schematic “ladder” diagrams and written descriptions explaining ladder diagram operation and system operation. Schematic diagrams shall identify external connections between the control panel/control panel devices and associated “field” equipment. These diagrams show interconnecting wiring by dashed lines and designate terminal assignments. If the termination information for field devices is not known at the time of the submittals, then underscores shall be shown on the drawings to draw attention to the missing information, and a revised set of drawings shall be shipped with the control panel to the project site with the missing information to allow CONTRACTOR terminations.

2. Shop drawings shall show conformance to the wiring and installation requirements of Part 3 of this Section.

3. UPS and battery load calculations show that the backup capacity and time meet the specified requirements.

4. A bill of material which enumerates devices associated with the control panel.

5. Include catalog cuts of control equipment including enclosures, overcurrent devices, relays, pilot devices, terminations, and wire troughs.

6. A listing of spare parts to be furnished.

B. Furnish written control panel operating procedures for normal such as startup, shutdown and abnormal operating conditions such as placing the equipment in a safe condition or resetting after an alarm or shut down triggered by equipment safety, etc. In addition to the copies provided in accordance with Sections 01 33 00 and 26 00 00 provide one laminated copy with each control panel specific to that control panel.

PART 2 -- PRODUCTS

2.1 GENERAL

A. The CONTRACTOR shall provide equipment, panels and stations to satisfy the functional requirements in the relevant mechanical equipment and Instrumentation and Control specifications and the Electrical Elementary Schematics. Each panel and station shall be fabricated with UL labeled components. Equipment not specifically indicated as being WORK of other Sections shall be provided under this Section. All equipment, panels and stations shall be wired under this Section.

B. The controls shall be 120-volt maximum. Where the electrical power supply is 208 volt or 480 volt the station shall be provided with a fused control power transformer. One lead on the secondary side shall be grounded except where specifically indicated otherwise. Control conductors shall be provided in accordance with Section 26 05 19 – Wire and Cabling.

C. Each panel and/or station shall be provided with identified terminal strips for the connection of external conductors. The CONTRACTOR shall provide sufficient terminal blocks to connect 25 percent additional conductors for future use. Termination points shall be identified in accordance with Shop Drawings. The panels and/or stations shall be the source of power for all controlled devices interconnected with the panels and/or stations. Equipment associated with the panels and/or stations shall be ready for service after connection of conductors to equipment, controls, panels and/or stations.

D. Exposed terminals of door-mounted devices shall be guarded to prevent accidental personnel contact with energized terminals.

E. Enclosures

1. Enclosures shall be NEMA rated and provided in accordance with Section 26 00 00 – Electrical Work General.

2. Outdoor enclosures shall be fabricated from stainless steel.

3. Enclosures shall be freestanding, pedestal-mounted, or equipment skid-mounted, as indicated. Internal control components shall be mounted on a removable mounting pan. Mounting pan shall be finished white.

4. Outdoor mounted enclosures and enclosures in semi-heated spaces shall be provided with thermostatically-controlled heaters. The heater shall be a 120-volt, enclosed fan driven type with integral thermostat, and mounted on the back panel. The heater shall be sized to maintain the panel inside temperature above 50°F with the facility (and any PLC's) shutdown. Heaters shall be **Hoffman model D-AH** series, or equal.

5. Each panel 12" by 12" and larger shall be provided with a door stop to secure the door in the open position.

6. Enclosures containing electronic devices located outdoors and not shaded by other structures shall be constructed with a white painted sun shield over the top and south, west and east facing sides. Enclosures with electronic devices such as Programmable Logic Controllers (PLC's), flowmeter transmitters, etc. shall have a closed loop air

conditioner on the north side. Louvers and/or openings which allow outside air into the enclosure are not acceptable.

7. Ventilation openings shall be protected from wind driven rain and have removable and reusable dust filters.

8. Enclosures for PLC's shall have an switched internal LED light and NEMA 15-amp duplex receptacle labeled "TOOLS ONLY" for use by programming laptops, etc.

9. Enclosures with power supplies shall have a door mounted white "120VAC Power Available" light and an alarm light for each power supply.

F. Disconnect Switches

1. Heavy duty, non-fusible, single throw switches shall be rated not less than 65 kAIC at 480 VAC.

2. Horsepower rated

3. UL listed

4. Padlockable in "Off" position and door interlock

5. Enclosure per area classification in Section 26 00 00 – Electrical Work, General.

6. 480 VAC, 3-phase, 3-pole.

7. Auxiliary control contact as applicable and where indicated.

8. As manufactured by **G.E., Eaton Electrical, Square D,** or equal.

G. Identification of panel-mounted devices, conductors, and electrical components shall be in accordance with Section 26 00 00 – Electrical Work, General.

H. Panel-mounted devices shall be mounted a minimum of 3-feet above finished floor elevation, but not higher than 6'-6" above finished floor, unless noted otherwise.

I. Where more contacts are shown or required for any type of relay coil, (control relay, time delay relay, latching relay, etc.), switch, or field device, the CONTRACTOR shall furnish, install and connect auxiliary relay(s) at no additional cost to the OWNER. Where interposing relays are required between devices but are not shown on the Contract Drawings, the CONTRACTOR shall furnish, install and connect interposing relay(s) at no additional cost to the OWNER.

J. Equipment safety devices shall be hard-wired into the equipment control wiring to shut down the equipment in any operating mode, or with the equipment mode selector switch in any operating position (HAND, AUTO, REMOTE, LOCAL, etc.). Equipment requiring the operator to reset the controls after correcting the adverse condition that triggered the shutdown shall be provided with a momentary RESET button, or equipment mode selector switch OFF position that accomplishes the same function.

2.2 PANEL/STATION COMPONENTS

A. Pushbuttons, selector switches, and pilot lights shall be the heavy-duty, oil-tight type, sized to 30 mm, and NEMA rated for the installation location. Miniature style devices are not acceptable. Devices shall be as manufactured by **G.E., Square D Class 9001 Type K, Eaton Electric Type 10250T, Allen-Bradley Bulletin 800 Type T Eaton Electric**, or equal.

B. Four (or more) position selector switches shall be of the heavy-duty type. Switches shall have a rotary blades engaging separate contact banks for each set of contacts shown. Each contact shall have a screw type terminal for connecting control wires. Each shall have a factory engraved legend plate and make-before-break or break-before-make contacts as indicated on the Contract Drawings. Four position selector switches shall be **Electroswitch series 31 single-hole**, or equal.

1. Lens colors shall be green for "run," "open," or "on"; red for "stopped," "closed," or "off"; and amber for alarm.

2. Pilot lights or 28 volts or less shall be Push-to-Test, light emitting diode (LED) type.

3. Pilot lights for greater than 28 volts shall be Push-to-Test, reduced voltage, transformer type. Lamp voltage shall be 12-volt maximum.

C. Relays shall be 3 PDT with 10-amp contacts, plug-in type with indicating light, rectangular blades and provided with sockets for screw-type termination and hold-down clips. Where more than 3 contacts are shown or required for a relay coil additional relay(s) shall be furnished installed and connected at no additional cost to the OWNER. Miniature or compact relays are not acceptable. Relays shall be as manufactured by **Square D 8501 Type KU, Eaton Electric Type D5, Allen-Bradley Bulletin 700 Type HB, Potter Brumfield,** or equal.

D. Latching relays shall be 2PDT with 10-amp contacts, indicating light, plug-in type utilizing rectangular blades and provided with sockets for screw-type termination and hold-down clips. Where more than 2 contacts are shown or required for a relay coil additional relay(s) or auxiliary relay(s) shall be furnished installed and connected at no additional cost to the OWNER. Relays shall be as manufactured by **Square D Class 8501 Type KL, Eaton Electric Type MR, Allen-Bradley Bulletin 700 Type HJ, Potter & Brumfield**, or equal.

E. Time delay relays shall be electronic, combination on delay, off delay, interval, and one-shot (selectable) with adjustable timing ranges plug-in type utilizing rectangular blades and provided with sockets for screw-type termination and hold-down clips. Time delay relays shall at least 2PDT with 10-amp contacts. Where more than 2 contacts are shown or required for a relay coil additional relay(s) or auxiliary relay(s) shall be furnished installed and connected at no additional cost to the OWNER. Time delay relays shall be **Square D Class 9050 Type JCK, Potter & Brumfield**, or equal.

F. Elapsed time meters shall be non-resettable type, read to a maximum of 99999.9 hours and shall be as manufactured by **General Electric, Eaton Electrical,** or equal.

G. Magnetic starters shall be:

1. NEMA rated, Size 1 minimum. IEC or dual NEMA/IEC rated type are not acceptable.

2. FVNR type unless indicated otherwise.

3. Combination starters with magnetic only instantaneous trip circuit breakers such as **Eaton Electrical HMCP, General Electric Mag-Break,** or equal. Breakers shall be rated 65 kAIC minimum.

4. Control transformers shall be provided with primary and secondary fuses, 120 V maximum control voltage. VA rating of transformer shall be based on devices on the control schematic.

H. Terminal blocks for control wiring shall be of the DIN rail mounting type rated at a minimum of 600-volt AC and minimum width of 8mm suitable for No. 12 AWG stranded wire minimum. Terminals shall be the solderless box lug type with pressure plates in actual contact with the wire to minimize wire breakage. Each terminal shall have a light-colored strip for marking the terminal number or circuit designation. Double high terminal blocks are not acceptable. Circuit isolating switches and fuse terminals shall include non-conducting pullers which can be removed with finger alone, no tools required. Terminals shall be **Square D Class 9080 Type M, Eaton Electric Type C383, Allen-Bradley Bulletin 1492 Type H and U**, or equal. Provide 25 percent spare terminals in each panel.

I. Audible alarm horns shall be 100 decibels at ten feet minimum with a volume adjusting screw, and 120 VAC operation. Horns shall include all parts required for mounting in the location shown on the Contract Drawings. Horns installed as part of panels shall be surface mounted or flush with the face of the panel. No conduit or adapter boxes shall be mounted externally on the panel surface. Horns shall include all components including tone generators to provide a complete product. Audible alarm horns shall be **Federal Signal Corp., Edwards, Allen-Bradley**, or equal.

J. Alarm beacons shall have a yellow lens at least 6 inches (150mm) in diameter, flashing, rotating or strobe lamp, and accept 120 VAC nominal voltage. Alarm beacons shall be surface mounted to be visible to personnel away from the facility at fault. Coordinate exact locations with OWNER during construction. No conduit or adapter boxes shall be mounted externally on the panel surface. Alarm beacons shall include all components including mounting adapters to provide a complete product. If the alarm beacon provides an audible alarm horn then a separate audible alarm horn does not need be furnished. Alarm beacons shall be **Allen-Bradley Bulletin 855BL**, or equal.

K. Direct current power supplies shall have a precision regulated voltage of 24 volts nominal. Power supplies shall have an excess rated capacity of 40 percent. Power supplies shall receive 120 VAC nominal input voltage, input fuse or circuit breaker and be enclosed on all sides with screw terminals for all user connections. Open power supplies or ones using soldered terminals shall not be accepted. Power supplies shall be of the redundant dual type or shall be two power supplies wired in parallel, fully fused and protected from feeding power into the other power supply. Each power supply shall have a relay output for signaling failure. Power supplies shall be **Moore Industries model SMP with SSM**, or equal.

2.3 FACTORY TESTING

A. Each panel/station shall be factory assembled and tested for sequence of operation prior to delivery.

2.4 SPARE PARTS

A. For the entire project provide:

1. A minimum of 10 percent spare lamps (minimum 2) and one spare lens for each color pilot lamp in each panel.

2. Five spare control fuses of each type (voltage, amperage, form) installed.

3. Two spare relays and bases of each type installed.

4. One power supply (and switching module if applicable) of each type installed

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Panels/stations shall be installed in accordance with Section 26 00 00 – Electrical Work, General and in accordance with the manufacturer's recommendations.

B. Panels/stations shall be protected at the site from loss, damage, and the effects of weather. Panels/stations shall be stored in an indoor, dry location. Heating shall be provided in areas subject to corrosion and humidity.

C. Panels/station interiors and exteriors shall be cleaned, and coatings shall be touched up to match original finish upon completion of the WORK.

D. Conduit, conductors, and terminations shall be installed in accordance with Section 26 00 00 – Electrical Work, General.

3.2 SIGNAL AND CONTROL CIRCUIT WIRING

A. Wiring Installation: All wires shall be run in plastic wireways except (1) field wiring, (2) wiring between mating blocks in adjacent sections, (3) wiring from components on a swing-out panel to components on a part of the fixed structure, and (4) wiring to panel-mounted components. Wiring runs from components on a swing-out panel to other components on a fixed panel shall be made up in tied bundles. These bundles shall be tied with nylon wire ties and shall be secured to panels at both sides of the "hinge loop" so that conductors are not strained at the terminals. Wire bundles from door mounted components shall land on terminals on the back panel before continuing to back panel mounted devices so the door wiring can easily be tested and field modified. Wire bundles from door mounted components to terminals on the back panel shall include a minimum of four spare wires.

B. Panels/stations shall be installed in accordance with Section 26 00 00 – Electrical Work, General and in accordance with the manufacturer's recommendations.

C. All external connections to and from panels shall terminate on terminal blocks except approved analog signal and communications cables.

D. Wire Marking: All conductors connected to a given electrical point shall be designated by a single unique number which shall be shown on all shop drawings. These numbers shall be marked on all conductors at every terminal.

E. Terminals and fuses for each conductor and shield drain wire of a twisted shielded pair or triad cable shall be mounted consecutively next to each other. The horizontal and vertical arrangement of the positive, negative and ground terminals shall be consistent in all panels.

3.3 EQUIPMENT IDENTIFICATION

A. Nameplates shall be provided for all components mounted in or on panels. In addition to name plates, control devices shall be equipped with standard collar-type legend plates. Nameplates shall meet the requirement of Section26 00 00 – Electrical Work, General.

B. Control devices mounted through the enclosures door(s) shall be identified on both the outside and inside of the door.

C. All conduits (filled or empty) terminating in panels shall be tagged in accordance with Section 26 05 33 - Electrical Raceway Systems.

D. The CONTRACTOR shall furnish typewritten fuse directory listing the location, type, voltage and ampere rating of each fuse installed in the panel.

3.4 FIELD TESTING

A. Each panel/station shall be tested again for functional operation in the field after the connection of external conductors and prior to equipment startup.

END OF SECTION

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SECTION 26 05 19 - WIRE AND CABLING

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide wire and cable, complete and operable, in accordance with the Contract Documents.

B. In the event that motors provided are larger horsepower than the motors indicated, raceways, conductors, starters, overload elements, and branch circuit protectors shall be revised as necessary to control and protect the increased motor horsepower in accordance with Section 26 05 10 - Electric Motors. Revisions are part of the WORK of this Section.

1.2 CONTRACTOR SUBMITTALS

A. The CONTRACTOR shall submit Shop Drawings in accordance with Sections 01 33 00 - Contractor Submittals and 26 00 00 - Electrical Work, General.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Conductors, include grounding conductors, shall be stranded copper. Aluminum conductor wire and cable will not be permitted. Insulation shall bear the UL label, the manufacturer's trademark, and identify the type, voltage, and conductor size. 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. Wire rated for 600 volts in duct or conduit for power and lighting circuits shall be Class B Type XHHW or XHHW-2 cross-linked polyethylene conforming to UL-44 - UL Standard for Thermoset-Insulated Wires and Cables. THHN/THWN wire shall not be permitted to be used for any power or control wiring in this project, except as specifically permitted.

2. Conductors for feeders as defined in Article 100 of the NEC shall be sized to prevent a voltage drop exceeding 3 percent at the farthest outlet of power, heating, and lighting loads, 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.

3. Conductors for branch circuits as defined in Article 100 of the NEC shall be sized to prevent 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.

4. Wiring for 600 volt class power and lighting shall be as manufactured by **Okonite**, **General Cable**, **Southwire**, or equal.

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 AWG.
3. Control wires inside panels and cabinets shall be machine tool grade type MTW, UL approved, rated for 90 degrees C at dry locations, and be as manufactured by **American, General Cable,** or equal.

C. Instrumentation Cable

1. Instrumentation cable shall be rated at 600 volts.
2. Individual conductors shall be No. 16 AWG stranded, tinned copper. Insulation shall be color coded pvc/nylon: black-white for 2 conductor cable and black-red-white for 3 conductor cable.
3. Instrumentation cables shall be composed of the individual conductors, an aluminum polyester foil shield, a No. 22 or larger AWG stranded tinned copper drain wire, and a PVC outer jacket with a thickness of 0.047-inches.
4. Single pair, No. 16 AWG, twisted, shielded cable shall be **Belden Part No. 3090A,** similar by **General Cable,** or equal.
5. Single triad, No. 16 AWG, twisted, shielded cable shall be **Belden Part No. 3091A,** similar by **General Cable,** or equal.

2.3 CABLE SPLICES AND 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 (wire nuts) 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 computer printable or pre-printed, self-laminating, self-sticking, as manufactured by **W.H. Brady, 3M,** or equal.

PART 3 -- EXECUTION

3.1 GENERAL

A. The CONTRACTOR shall provide, terminate and test all power, control, and instrumentation conductors.

B. The CONTRACTOR shall, as a minimum, provide the number of control wires listed in the conduit schedule or on the Contract Drawings. Excess wires shall be treated as spares.

3.2 INSTALLATION

A. Conductors shall not be pulled into raceway until raceway has been cleared of moisture and debris.

B. Pulling tensions on raceway cables shall be within the limits recommended by the cable manufacturer. Wire pulling lubricant, where needed, shall be UL approved.

C. Instrumentation wire shall not be run in the same raceway with power and control wiring except where specifically indicated.

D. Wire in panels, cabinets, and wireways shall be neatly grouped using nylon tie straps, and shall be fanned out to terminals.

3.3 SPLICES AND TERMINATIONS

A. General

1. Wire taps and splices shall be properly taped and insulated according to their respective classes.
2. In general, there shall be no cable splices in underground manholes or pullboxes. If splices are necessary, the cables shall be spliced using submersible cable splices, suitable for continuous submergence. Splices in underground manholes and pullboxes may be made only with the approval of the ENGINEER.
3. Stranded conductors shall be terminated directly on equipment box lugs making sure that conductor strands are confined within lug. Use forked-tongue lugs where equipment box lugs have not been provided.
4. Excess control and instrumentation wires shall be long enough to terminate at any terminal block in the enclosure, be properly taped, be identified with origin, and be neatly coiled.

B. Control Wire and Cable

1. Control conductors shall be spliced or terminated only at the locations indicated and only on terminal strips or terminal lugs of vendor furnished equipment.
2. In control panels/stations, control wire and spare wire shall be terminated to terminal strips.
3. The CONTRACTOR shall provide as a minimum the number of control wires listed in the conduit schedule or as indicated in the Contract Documents. Excess wires shall be treated as spares.

C. Instrumentation Wire and Cable

1. Shielded instrumentation cables shall be grounded at one end only, preferably the receiving end on a 4-20 mA system.
2. Two and 3 conductor shielded cables installed in conduit runs which exceed available standard cable lengths may be spliced in pullboxes with the prior approval of the ENGINEER. Such cable runs shall have only one splice per conductor.

D. Power Wire and Cable

1. 120/208-volt, 120/240-volt, and 480/277-volt branch circuit conductors may be spliced in suitable fittings at locations determined by the CONTRACTOR. Cables rated above 2,000 volts shall be spliced or terminated only at equipment terminals indicated.
2. Splices to motor leads in motor terminal boxes shall be wrapped with mastic material to form a mold and then shall be taped with a minimum of 2 layers of varnished cambric tape over-taped with a minimum of 2 layers of high temperature tape.

3.4 CABLE IDENTIFICATION

A. **General:** Wire and cable shall be identified for proper control of circuits and equipment and to reduce maintenance effort. Identification shall be installed at every termination point.

B. **Identification Numbers:** The CONTRACTOR shall assign to each control and instrumentation wire and cable a unique identification number. Numbers shall be assigned to 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 shall be assigned a number which shall be attached to the cable at intermediate pull boxes and at stub-up locations beneath free-standing equipment. It is expected that the cable number shall form a part of the individual wire number. Individual control conductors and instrumentation cable shall be identified at pull points as described above. The instrumentation cable numbers shall incorporate the loop numbers assigned in the Contract Documents.
2. 120/208-volt system feeder cables and branch circuit conductors shall be color coded as follows: Phase A - black, Phase B - red, Phase C - blue, and Neutral - white. The 120/240-volt system conductors shall be color coded as follows: Line 1 - Black, Line 2 - Red, and Neutral - White. The 480/277-volt system conductors shall be color coded as follows: Phase A - Brown, Phase B - Orange, Phase C - Yellow, and Neutral - Gray. Color coding tape shall be used where colored insulation is not available. Branch circuit switch shall be yellow. Insulated ground wire shall be green, and neutral shall be gray. Color coding and phasing shall be consistent throughout the Site, but 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. Any phase changes necessary for proper rotation shall be made at the driven equipment and not in the local disconnect.
3. General purpose AC control cable shall be red. General purpose DC control cable shall be blue.
4. Spare cable shall be terminated on terminal screws and shall be identified with a unique number as well as with destination.
5. 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-95-658/NEMA WC70 - 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 01 33 00 - Contractor Submittals, prior to shipment of cable. The following field tests (in addition to the tests specified in Section 26 01 26 - Electrical Tests) shall be the minimum requirements:

1. Insulation resistance testing, using a DC megohmeter, shall be performed on cables operating at more than 2,000 volts to ground. Time-resistance readings shall be taken

and recorded at intervals of 30 seconds and one minute. Time-resistance voltage levels shall be per the cable manufacturer's recommendations.

2. Power cable rated at 600 volts shall be tested for insulation resistance between phases and from each phase to a ground using a megohmeter.
3. Field testing shall be done after cable is installed in the raceways.
4. 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.
5. Cables failing the tests 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 cable shall be tested for continuity, polarity, undesirable ground, and origination. Such tests shall be performed after installation and prior to placing cable in service.

END OF SECTION

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SECTION 26 05 26 – GROUNDING

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Provide the electrical grounding system, complete and operable, as indicated in accordance with the Contract Documents.

B. The requirements of Section 26 00 00 – Electrical Work, General apply to this Section.

C. Single Manufacturer

1. 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 the requirements of Section 01 33 00 – Contractor Submittals and Section 26 00 00 – Electrical Work, General.

B. Shop Drawings

1. Submit 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 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.

B. Conductors shall be No. 1/0 unless indicated otherwise.

C. Ground Rods

1. Unless indicated otherwise, provide ground rods minimum of 3/4 inch in diameter, 10 feet long, and with a uniform covering of electrolytic copper metallically bonded to a rigid steel core.

2. Provide corrosion-resistant copper-to-steel bond.

3. The rods shall conform to UL 467.

4. The rods shall be of the sectional type, joined by threaded copper alloy couplings.

D. Make buried and concrete-encased cable-to-cable and cable-to-ground rod connections using exothermic welds by **Cadweld, Thermoweld,** or equal, or irreversible compression connections.

E. Exposed Connectors

1. Exposed grounding connectors shall be of the compression type (connector-to-cable), constructed of high-copper alloy, and manufactured specifically for the particular grounding application.

2. The connectors shall be **FCI-Burndy, O.Z. Gedney**, or equal.

F. Use grounding clamps to bond each separately-derived system to the grounding electrode conductors.

G. Equipment Grounding Circuit Conductors

1. The conductors shall be the same type and insulation as the load circuit conductors.

2. The minimum size shall be as outlined in Table 250.122 of the National Electrical Code, unless indicated otherwise.

3. Metallic conduit systems shall have an equipment grounding wires as well as being equipment grounding conductors themselves.

H. Grounding Materials Manufacturer, or Equal

1. **Copperweld**

2. **Thermoweld**

3. **FCI-Burndy**

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.

C. Do not use bolts for securing the motor box to the frame or the cover for grounding connectors.

D. Sizes shall be as indicated on the Conduit Schedule and in accordance with NEC Article 250.

E. Route the conductors inside the raceway.

F. Provide a grounding-type bushing for secondary feeder conduits that originate from the secondary section of each switchboard, or panelboard.

G. Individually bond the raceway to the ground bus in the secondary section.

H. Provide a green insulated wire as grounding jumper from the ground screw to a box grounding screw, and, for grounding type devices, to the equipment grounding conductor.

I. Provide a separate grounding conductor in each individual raceway for parallel feeders.

J. Interconnect the secondary switchboard or panelboard neutral bus to the ground bus in the transformer secondary compartment only at the service entrance point or after a transformer.

K. Provide grounding, including trenching, splices, ground rods, and connections to each existing equipment and structure as required by the Code and AHJ.

L. Measure ground impedance in accordance with IEEE STD 81 after installation but before connecting the electrode to the remaining grounding system.

M. Low Voltage Grounded System (600V or less)

1. A low-voltage grounded system is defined as a system where the local power supply is a transformer, with the transformer secondary grounded.

2. Grounding system connections for a premises-wired system supplied by a grounded AC service shall be provided with a grounding electrode connector connected to the grounded service conductor at each service, in accordance with the NEC.

3. 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.

N. Embedded Ground Connections

1. Underground and grounding connections embedded in concrete shall be UL-listed ground grid connectors.

2. The connection shall be made in accordance with the manufacturer's instructions.

3. Do not conceal or cover ground connections until the ENGINEER or an authorized representative has established that every grounding connection conforms to the requirements of the Contract Documents and has given the CONTRACTOR written confirmation.

O. Ground Ring

1. Furnish trenching and materials as necessary to install the ground ring as indicated.

2. The bonding conductor shall be in direct contact with the earth and of the indicated size.

3. Provide a minimum burial depth of 36 inches or as indicated on the Drawings, whichever is greater.

4. Re-compact disturbed soils to their original density in 6-inch lifts.

P. Ground Rods

1. Provide ground rods at the indicated locations.

2. A single electrode that does not have resistance-to-ground of 5 ohms or less shall be augmented by additional electrodes to obtain this value.

3. Take the resistance-to-ground measurement during dry weather, a minimum of 48 hours after a rainfall.

4. Rods forming an individual ground array shall be equal in length.

Q. Shield Grounding

1. Shielded instrumentation cable shall have its shield grounded at one end only unless the Shop Drawings indicate that the shield will be grounded at both ends.

2. The grounding point shall be at the control panel or at the receiving end of the signal carried by the cable.

3. The termination of the shield drain wire shall be on its own terminal screw.

4. Jumper together the terminal screws, using manufactured terminal block jumpers or a No. 14 green insulated conductor.

5. Connect the ground bus via a green No. 12 conductor to the main ground bus for the panel.

END OF SECTION

SECTION 26 05 33 - ELECTRICAL RACEWAY SYSTEMS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Provide electrical raceway systems, complete and in place, as indicated in accordance with the Contract Documents.

B. In the event that individual equipment loads provided are larger than indicated in the Contract Documents, revise raceways, conductors, starters, overload elements, and branch circuit protectors as necessary in order to control and protect the increased connected load in conformance to NEC requirements as part of the WORK.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Contractor Submittals, and Section 26 00 00 – Electrical Work, General.

B. Shop Drawings

1. Submit complete catalog cuts of raceways, fittings, boxes, supports, and mounting hardware, marked where applicable to show proposed materials and finishes.

2. As-Built Drawings

a. Prepare as-built drawings of encased concealed and exposed raceways, ducts, raceways, junction boxes, pull boxes, terminal boxes, and electrical and instrumentation equipment.

b. Document all grounding connections, and neutral to ground connections.

c. Document all phasing for all single phase connections.

d. Furnish the drawings to the ENGINEER in accordance with THE SUMMARYs of Section 01 33 00 – Contractor Submittals.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Pull, junction and terminal boxes, fittings, and other indicated enclosures that are dedicated to the raceway system shall comply with THE SUMMARYs of this Section.

2.2 CONDUIT

A. Rigid Aluminum (RAL) Conduits shall not be used.

B. Rigid Galvanized Steel (RGS) Conduit

1. Provide rigid steel conduit manufactured from mild steel, hot-dip galvanized inside and out.

2. Provide rigid steel conduit manufactured in accordance with NEMA C80.1 – Electrical Rigid Steel Conduit, and UL-6 – Electrical Rigid Metal Conduit - Steel.

3. Manufacturer, or Equal

a. **Allied Tube & Conduit**

b. **Triangle**

c. **Wheatland Tube**

C. Rigid Non-Metallic Conduit

1. Provide rigid non-metallic conduit manufactured from Schedule 40 or 80 PVC, as indicated, and sunlight-resistant.
2. Provide rigid non-metallic conduit manufactured in accordance with NEMA TC-2 - Electrical Plastic Tubing and Conduit, and UL-651 - Standard for Rigid Non-metallic Conduit.
3. Manufacturer, or Equal

   a. **Carlon**

   b. **Cantex**

D. Rigid PVC-Coated Galvanized Steel (RPGS) Conduit

1. The conduit shall meet THE SUMMARYs for RGS conduit as indicated above.
2. Bond a PVC coating to the outer surface of the galvanized conduit.
3. Ensure that the bond between the coating and the conduit surface is greater than the tensile strength of the coating.
4. Provide the inside surfaces and threads of the conduit with a 2-mil urethane coating.
5. Provide a PVC coating thickness not less than 40 mils.
6. The PVC-coated RGS shall be manufactured in accordance with the following standards:

   a. UL-6

   b. ANSI C80.1

   c. NEMA RN1 - PVC Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit

7. Manufacturer, or Equal

   a. **Robroy Industries, Perma-Cote**

   b. **Robroy Industries, Plasti-Bond RedH2OT**

   c. **Robroy Industries, Korkap**

   d. **Thomas & Betts, Ocal Blue**

E. Polyolefin Polymer-Coated Rigid Galvanized Steel Conduit:

1. All conduit shall be hot dipped galvanized inside and out with hot dipped galvanized factory-cut threads. The Zinc coating shall be intact, uncoated, and shall not impede electrical ground conductivity.
2. Provide all necessary manufacturer material as may be needed to ensure a fully complete, continuously sealed, undamaged conduit system.
3. Provide additional polymer and repair any abrasions to polymer coating.

4. Polymer-coated RGS conduit shall be resistant to UV damage and deterioration when exposed outdoors.
5. All PP-coated conduit, fittings, and accessories shall be supplied by the same manufacturer.
6. All couplings and fittings shall be provided with PP-coated sleeves and seals, unless otherwise approved by the ENGINEER.
7. Material:
    a. Conduit: Meet requirements of ANSI C80.1 and UL 6.
    b. Polyolefin Polymer Coating:
        1) Minimum 20 mils nominal thickness, exterior coating bonded to metal.
        2) Minimum 2 mils nominal thickness, interior coating bonded to metal.
8. Manufacturer, or Equal
    a. **Gafco Green**
    b. **Cor-Shield**

F. Liquid-Tight Flexible Conduit
1. Provide liquid-tight flexible conduit constructed of a flexible galvanized metal core with a sunlight-resistant thermoplastic outer jacket.
2. Provide liquid-tight flexible conduit manufactured in accordance with THE SUMMARYs of UL-360 - Steel Conduits, Liquid-Tight Flexible.
3. Manufacturer, or Equal
    a. **Anaconda, Sealtite**
    b. **Electriflex, Liquatite**

G. Electrical Metallic Tubing (EMT) or Intermediate conduit (IMC) will not be accepted.

2.3 FITTINGS AND BOXES

A. General
1. For use with metallic conduit, provide cast and malleable iron fittings of the threaded type with 5 full threads.
2. Fittings and Boxes
    a. Provide fittings and boxes with neoprene gaskets and non-magnetic stainless steel screws.
    b. Attach covers by means of holes tapped into the body of the fitting.
    c. Covers for fittings attached by means of clips or clamps will not be accepted.
    d. Terminal boxes shall be provided with a removable metal interior back panel for mounting terminal blocks, etc.
3. Provide boxes larger than standard cast or malleable types manufactured of Type 304 or Type 316 stainless steel, NEMA 4X.

4. Terminations
    a. In outdoor areas, terminate conduit in rain-tight hubs as manufactured by Myers, O.Z. Gedney, Appleton, or equal.
    b. In other than outdoor areas, provide sealed locknuts and bushings.

B. Malleable Iron Fittings and Boxes
1. For use with galvanized steel conduit, provide fittings and boxes constructed of malleable iron or gray-iron alloy with zinc plating.
2. Manufacturer, or Equal
    a. **O.Z. Gedney**
    b. **Crouse-Hinds**
    c. **Appleton**

C. PVC Fittings and Boxes
1. For use with rigid non-metallic conduit, provide fittings manufactured of solvent-welded PVC.
2. Provide boxes manufactured of PVC or fiberglass reinforced polyester (FRP).
3. Manufacturer, or Equal
    a. **Carlon**
    b. **Crouse-Hinds**
    c. **Hoffman**
4. Provide welding solvent as required for the installation of non-metallic conduit and fittings.

D. PVC-Coated Fittings
1. For use with PVC-coated RGS, provide PVC-coated coated that are the products of the same manufacturer as the conduit.
2. Provide male and female threads and internal surfaces with a 2-mil urethane coating.

E. Stainless Steel Boxes
1. Provide stainless steel boxes with PVC-coated RGS conduit and where indicated.
2. Provide NEMA 4X stainless steel boxes, constructed of Type 304 or 316 stainless steel.
3. Provide stainless steel of a minimum of 14-gauge thickness, with a brushed finish.
4. Door Hinges
    a. Provide doors with full-length stainless steel piano hinges.
    b. Non-hinged boxes will not be accepted.
5. Manufacturer, or Equal
    a. **Hoffman**
    b. **Rohn**

c. **Hammond**

F. Sheet Steel Boxes

1. Sheet steel boxes shall be galvanized steel outlet and switch boxes.
2. Manufacturer, or Equal
   a. **Raco**
   b. **Steel City**
   c. **Appleton Electric**

2.4 WIREWAY

A. General

1. Provide wireway of the lay-in type and NEMA-rated for the area in which it is to be installed in accordance with THE SUMMARYs of Section 26 00 00 – Electrical Work, General.
2. Separate power, control, signal and communications cables by grounded metallic dividers in wireways or run in separate wireways.

B. Fittings and Covers

1. Provide fittings and sections with non-magnetic stainless steel screws.
2. Attach covers by hinges and clamps to the bodies.
3. Covers attached by means of clips or screws will not be accepted.
4. Provide covers and bodies constructed of minimum 14-gauge steel.

C. Grounding

1. Ground the steel and aluminum wireway bodies.
2. Provide steel dividers with steel wireways and ground by means of an individual grounding conductor.
3. Non-metallic dividers will not be accepted.

D. Terminations

1. In outdoor areas, terminate conduit in rain-tight hubs as manufactured by **Myers, O.Z. Gedney**, or equal.
2. In other than outdoor areas, provide sealed locknuts and bushings.

PART 3 -- EXECUTION

3.1 GENERAL

A. Run wiring in raceway unless indicated otherwise.

B. Install raceways between equipment as indicated.

C. Provide raceway systems that are electrically and mechanically complete before conductors are installed.

D. Bends and Offsets

1. Provide bends and offsets that are smooth and symmetrical, and accomplished with tools designed for this purpose.

2. Provide factory elbows wherever possible.

E. Combined Raceways (power and control/signal) shall not be allowed except where specifically shown on the drawings.

F. Routing

1. Where raceway routings are indicated, follow those routings to the extent possible.

2. Where raceways are indicated but routing is not indicated, such as home runs or on conduit developments and schedules, raceway routing shall be the CONTRACTOR's choice and provided in strict accordance with the NEC as well as customary installation practice.

3. Provide the raceway encased, exposed, concealed, or under-floor as indicated, except conceal conduit in finished areas unless specifically indicated otherwise.

4. Adjust routings in order to avoid obstructions.

G. Coordination

1. Coordinate between trades prior to installing the raceways.

2. The lack of such coordination shall not be justification for extra compensation, and any costs for removal and re-installation to resolve conflicts shall be part of the Contract Price.

H. Support wireways in accordance with the manufacturer's recommendations for the seismic requirements indicated in Section 26 00 00 – Electrical Work, General.

I. Install exposed raceways parallel or perpendicular to structural beams.

J. Expansion Fittings

1. Install expansion fittings with external bonding jumpers wherever exposed raceways cross building expansion joints.

2. Install expansion/deflection fittings where conduit movement is expected in more than one dimension, and where conduits transition out of structures in locations where differential settlement may occur.

3. Encased Expansion Fittings

a. Install encased expansion fittings wherever encased conduits cross building expansion joints.

b. Deflection type fittings shall not be required for encased conduits crossing an expansion joint within a single structure.

4. Provide expansion and expansion/deflection fittings constructed of the same material as the raceway to which they are installed.

K. Install expansion fittings with bonding jumpers wherever raceways cross building expansion joints.

L. Install exposed raceways at least 1/4 inch from walls or ceilings except that at locations above finished grade where damp conditions do not prevail, install exposed raceways at least 1/4 inch from the face of walls or ceilings by the use of clamp backs or struts.

M. Wherever contact with concrete or dissimilar metals can produce galvanic corrosion of equipment, provide a means of suitable insulation in order to prevent such corrosion.

3.2 CONDUIT

A. Provide exposed conduit manufactured of rigid galvanized steel, except as follows and unless indicated otherwise:

1. For conduit containing only grounding system bonding conductors, provide Schedule 80 PVC conduit.

B. Power conduit encased in concrete shall be constructed of Schedule 40 PVC.

C. Analog control or instrumentation conduit shall be RGS.

D. Concrete Encasement

1. Where PVC or RGS conduit is stubbed up from a concrete encasement, provide a PVC-coated RGS elbow.

2. The conduit shall emerge from the concrete in a direction perpendicular to the surface whenever possible.

3. Do not encase conduit in the bottom floor slab below grade.

E. Size

1. Provide exposed conduit of 3/4-inch minimum trade size.

2. Provide encased conduit of one-inch minimum trade size.

F. Install supports at distances required by the NEC.

G. 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.

H. Penetrations

1. Provide conduit passing through walls or floors with plastic sleeves.

2. Perform core drilling in accordance with THE SUMMARYs of Section 26 00 00 – Electrical Work, General.

3. Conduits passing through a slab, wall, or beam shall not significantly impair the strength of the construction.

I. Conduits embedded within a slab, wall, or beam (other than those merely passing through) shall meet the following requirements:

1. Conduits with their fittings embedded within a column shall not displace greater than 4 percent of the gross area of cross section;

2. Conduits shall not be larger in outside dimension than 1/3 the overall thickness of the slab, wall, or beam in which it is embedded; and,

3. Conduits shall not be spaced closer than 3 outside diameters on centers.

J. Place the conduit such that cutting, bending, or displacing reinforcement from its proper location will not be required.

K. Coat threads with a conductive lubricant before assembly.

L. Joints

1. Provide joints that are tight, thoroughly grounded, secure, and free of obstructions in the pipe.

2. Adequately ream the conduit in order to prevent damage to the wires and cables inside.

3. Use strap-wrenches and vises to install the conduit, in order to prevent wrench marks on the conduit.

4. Replace conduit with wrench marks.

M. Slope

1. Wherever possible, slope the conduit runs to drain at one or both ends of the run.

2. Wherever conduit enters a substructure below grade, slope the conduit in order to drain water away from the structure.

3. Take extreme care in order to avoid pockets or depressions in the conduit.

N. Installation of rigid steel conduit though a core-drilled hole in an exterior wall below-grade shall utilize a sealing device as manufactured by **Link Seal**, or equal.

O. Connections

1. Make connections to motors and other equipment subject to vibration by using liquid-tight flexible conduit not exceeding 3 feet in length.

2. Provide equipment subject to vibration that is normally provided with wiring leads with a cast junction box for the make-up of connections.

P. Provide conduit seal fittings at the following locations:

1. At thermal boundaries in accordance with the NEC.

Q. Empty Conduits

1. Tag empty conduits at both ends to indicate the final destination.

2. Where it is not possible to tag the conduit, identify the destination by means of a durable marking on an adjacent surface.

3. Install a pull-cord in each empty conduit in floors, panels, manholes, equipment, and the like.

4. Install a removable plug on empty conduits that terminate below grade, in vaults, manholes, handholes, and junction, terminal or pull boxes.

R. Identification of Conduits

1. Identify conduits at ends and at pulling points.

2. Identification shall be the unique conduit number assigned in the Contract Documents.

3. Other than 120 VAC panelboard circuits, if a conduit has not been assigned a unique number in the Contract Documents, assign a unique number following the numbering scheme used in the Contract Documents.

4. Assign a unique number to 120 VAC panelboard circuits, similar to the cable numbering scheme used in the Contract Documents.

5. Provide conduit identification by a stamped or engraved non-corroding metal tag attached to the conduit bushing.

6. Provide an engraved phenolic nameplate in accordance with THE SUMMARYs of Section 26 00 00 – Electrical Work, General, or a computer printed self-adhesive label attached to the equipment or enclosure inside which the conduit terminates.

7. Markings with a pen or paint will not be accepted.

S. Identification of Pull Boxes, Terminal Boxes and Junction Boxes

1. Identify pull boxes, terminal boxes and junction boxes.

2. Identification shall be the unique conduit number assigned in the Contract Documents, or if not assigned a unique number the CONTRACTOR shall assign one following the numbering scheme used in the Contract Documents.

3. Provide box identification by a stamped or engraved non-corroding metal tag or an engraved phenolic nameplate, in accordance with THE SUMMARYs of Section 26 00 00 – Electrical Work, General, and attached to the box or enclosure.

4. Markings with a pen or paint will not be accepted.

T. Provide conduit for data cables in accordance with the equipment manufacturer's recommendations, especially regarding separation from low- and medium-voltage power raceways.

END OF SECTION

SECTION 26 05 36 - WIRING DEVICES

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide wiring devices, complete and operable, as indicated in accordance with the Contract Documents.

B. The requirements of Section 26 00 00 – Electrical Work, General apply to this Section.

C. Single Manufacturer

1. 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 the requirements of Section 01 33 00 – Contractor Submittals.

B. Shop Drawings

1. Submit complete catalog cuts of switches, receptacles, enclosures, covers and appurtenances, marked to clearly identify the proposed materials.

2. Submit documentation showing that the proposed materials comply with the requirements of NEC and U.L.

3. Submit documentation of the manufacturer's qualifications.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Devices shall carry the U.L. label.

B. Color

1. General purpose duplex receptacles and toggle switch handles shall be brown everywhere except in finished rooms where they shall be ivory.

2. Special purpose receptacles shall have a body color as indicated.

C. Receptacles and switches shall be of specification grade and shall conform to NEMA WD-1, Federal Specifications W-C-596E and W-S-896E, respectively.

2.2 LIGHTING SWITCHES

A. Local branch switches shall be of the toggle type, rated at 20 amperes, 120-277 VAC, and shall be **General Electric Cat. No. GE-5951-1** for single pole, **GE-5953-1** for 3 way and **GE-5954-1** for 4 way, similar types as manufactured by **Hubbell, Leviton,** or equal.

2.3 GENERAL PURPOSE RECEPTACLES

A. Duplex receptacles that are rated at 125V, 20 amperes, shall be of the polarized 3-wire type for use with a 3-wire cord with grounded lead, and one designated stud shall be permanently grounded to the conduit system in accordance with NEMA 5-20R.

B. Dry Areas

1. Duplex 120V receptacles for dry areas shall be **G.E. 5362, Hubbell 5362,** or equal.

2. Single receptacles for dry areas shall be **G.E. 4102, Hubbell 6361,** or equal.

C. Damp/Wet Areas

1. Receptacles for damp/wet locations shall be weather-resistant-listed in accordance with NEC, Article 406.8.

2. Duplex 120V receptacles for damp/wet areas shall be **Hubbell HBL5362IWR**, or equal.

D. GFCIs

1. Ground-fault circuit-interrupting receptacles (GFCIs) shall be installed at the indicated locations and as required by the NEC.

2. GFCIs shall be duplex receptacles, of specification grade, and tripping at 5 mA for Class A usages, and 20 mA for Class B usages.

3. GFCI ratings shall be 125V, 20 amperes, NEMA WD-1, configuration 5-20R, and capable of interrupting 5,000 amperes without damage.

4. GFCIs shall be weather resistant-listed in accordance with NEC, Article 406.8.

5. Feed-through-type GFCIs serving standard receptacles will not be permitted.

6. GFCIs shall be **Hubbell GFR5362SGI** or similar as manufactured by **Bryant, Leviton,** or equal.

2.4 ENCLOSURES AND COVERS

A. Surface-mounted switches and receptacles shall be housed in FS- or FD-type weatherproof conduit fittings.

B. Switch and receptacle covers on surface-mounted boxes shall be constructed of die-cast copper-free aluminum.

C. In finished areas, switch and receptacle boxes shall be provided with "super stainless steel covers" as manufactured by **Harvey Hubbell, Arrow Hart, Bryant,** or equal.

D. In areas where cast boxes are used, switch and receptacle covers shall be **Crouse-Hinds Catalogue No. DS185 and WLRD-1, or Adalet No. WSL** and **WRD,** or equal.

E. Wet Locations

1. Receptacles in wet locations shall be provided with a hinged locking metallic cover/enclosure marked "Suitable for Wet Locations while-in-use" and "UL Listed."

2. Provide a gasket between the enclosure and the mounting surface, and between the hinged cover and mounting plate/base.

3. The cover shall be **TayMac Specification Grade**, or equal.

2.5 RECEPTACLE – SPECIAL PURPOSE

A. Special purpose receptacles shall be provided with the ratings and number of poles as indicated or required for the proposed purpose.

B. Provide a matching plug with cord-grip features with each special purpose receptacle.

2.6 NAMEPLATES

A. Provide nameplates or equivalent markings on the switch enclosures to indicate the ON and OFF positions of each switch.

B. ON and OFF for 3-way or 4-way switches will not be accepted.

C. Provide receptacles for special purposes with nameplates indicating their use.

D. Nameplates shall meet the requirements of Section 26 00 00 – Electrical Work, General.

PART 3 -- EXECUTION

3.1 GENERAL

A. Perform WORK in accordance with the requirements of the NEC.

3.2 CONNECTION

A. Rigidly attach wiring devices in accordance with the NEC and as indicated, avoiding interference with other equipment.

B. Securely fasten nameplates using screws, bolts, or rivets centered under or on the device, unless otherwise indicated.

C. Receptacles indicated to be powered by uninterruptible power supplies (UPS) shall have a nameplate installed directly above the receptacle that reads:

1. (first line) “UPS-POWERED”

2. (second line) “NO TOOLS”

D. Nameplates shall meet the requirements of Section 26 00 00 – Electrical Work, General, and shall consist of a red plate with white letters a minimum of 1/4 inch tall.

3.3 GROUNDING

A. Devices, including switches and receptacles, shall be grounded in accordance with NEC, Article 250, and Section 26 05 26 – Grounding.

B. Switches and associated metal plates shall be grounded through the switch mounting yoke, outlet box, and raceway system.

C. Flush Receptacles

1. Flush receptacles and their metal plates shall be grounded through positive ground connections to the outlet box and grounding system.

2. Maintain the ground to each receptacle by a spring-loaded grounding contact to the mounting screw, or by a grounding jumper, each making a positive connection to the outlet box and grounding system at all times.

D. Receptacles served from an uninterruptible power supply shall be provided with an isolated grounding conductor from the serving power panelboard.

3.4 FIELD TESTING

A. Provide checkout, field, and functional testing of wiring devices in accordance with Section 26 00 00 – Electrical Work, General.

B. Test each receptacle for polarity and ground integrity, using a standard receptacle tester.

END OF SECTION

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SECTION 26 05 43 - UNDERGROUND RACEWAY SYSTEMS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Provide underground raceway systems, complete and in place, as indicated in accordance with the Contract Documents.

B. Manholes, pullboxes, and fittings that are dedicated to the underground raceway system shall comply with the requirements of this Section.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals, and Section 26 00 00 – Electrical Work, General.

B. Shop Drawings

1. Submit complete catalog cuts of all raceways, fittings, pullboxes, and manholes, marked where applicable in order to show proposed materials and finishes.

C. As-Built Drawings

1. Prepare as-built drawings of encased concealed and exposed raceways, ducts, raceways, junction boxes, pull boxes, and electrical and instrumentation equipment.
2. Show routings, burial depths, manhole and handhole locations and sizes, and where applicable, connections to drainage systems.
3. Furnish the drawings to the ENGINEER in accordance with the requirements of Section 01 33 00 – Contractor Submittals.

PART 2 -- PRODUCTS

2.1 PULLBOXES

A. Frames and Covers

1. Provide traffic-type covers with an H-20 loading, except as otherwise indicated.
2. Identify pullbox covers as "ELECTRIC" by providing raised letters cast into the covers.

B. Equip pullboxes with pulling-in irons, opposite and below each ductway entrance.

C. Provide pullboxes with closed bottoms; open-bottom pullboxes will not be accepted.

D. Precast Pullboxes Manufacturer, or Equal

1. **Jensen Precast**
2. **Mack**
3. **Quikset**
4. **U.S. Precast**

2.2 DUCTBANKS

A. Provide underground ducts constructed of Schedule 40 PVC. Ductbanks are not required to be concrete encased. Provide concrete cover over underground ducts where required by the NEC.

B. Identification Tape

1. Provide continuous lengths of underground warning tapes located 12 inches above and parallel to the ductbanks.
2. Provide tape consisting of 6-inch wide polyethylene film, imprinted with "CAUTION - ELECTRIC UTILITIES BELOW."
3. Provide tape that contains a non-ferrous metal foil conductor sandwiched in the tape for detection purposes.
4. Tape Manufacturer, or Equal: **Brady**

PART 3 -- EXECUTION

3.1 GENERAL

A. Install underground raceways between pullboxes as indicated.

B. Raceway systems shall be electrically and mechanically complete before conductors are installed.

C. Provide bends and offsets that are smooth and symmetrical, and fabricated with tools designed for this purpose.

D. Use factory elbows wherever possible.

E. To the extent possible, follow the raceway routings as indicated on the Drawings.

F. Adjust the indicated routings as necessary in order to avoid obstructions.

G. Bring identification tape trace wires to above grade at each end to allow connection of tracing signal generator.

H. Coordination with Other Trades

1. Coordinate with other trades prior to installation of raceways.
2. The lack of coordination shall not be justification for extra compensation.
3. Perform removal and re-installation to resolve conflicts as part of the WORK.

3.2 DUCTBANKS

A. Install ductbanks in accordance with the following criteria:

1. Assemble the duct using high-impact, non-metallic spacers and saddles in order to provide conduits with vertical and horizontal separation.
2. Set the plastic spacers every 5 feet.

3. Anchor the duct array every 5 feet in order to prevent movement during the placement of backfill.
4. Lay the duct on a grade line of at least 3 inches per 100 feet, sloping towards pullboxes.
5. Install the duct and adjust the pullbox depths such that the top of the concrete envelope is a minimum of 18 inches below grade and a minimum of 24 inches below roadways.
6. Accomplish changes in direction of the duct envelope by more than 10 degrees horizontally or vertically by using bends with a minimum radius 24 times the duct diameter.
7. Stagger duct couplings a minimum of 6 inches.
8. Provide select backfill or sand for the bottom of the trench.
9. Cleaning
    a. Clean each bore of the completed ductbank by drawing through it a standard flexible mandrel, one foot long and 1/4 inch smaller than the nominal size of the duct.
    b. After passing the mandrel, draw through a wire brush and swab.
10. For spare raceways that are not indicated to contain conductors, provide a 1/8-inch polypropylene pull cord installed throughout the entire length of the raceway. Cover the ends of all spare raceways.

B. Grout duct entrances smooth, and terminate ducts with flush end bells.

C. Assemble sections of pre-fabricated pullboxes using waterproof mastic, and set on a 6-inch bed of gravel as recommended by the manufacturer or as required by field conditions.

D. Provide watertight ductbank penetrations through walls of pullboxes, and building walls below grade.

E. When duct enters the building on a concrete slab on grade transition to rigid steel PVC-coated conduits on stub-ups.

F. Sealing

1. Where an underground conduit enters a structure through a concrete roof or a membrane-waterproofed wall or floor, provide a **Link-Seal** or equal sealing device.
2. Use the sealing device with rigid steel conduit.
3. Transition from PVC to rigid steel conduit prior to building entry.

END OF SECTION

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SECTION 26 05 73 – PROTECTIVE DEVICE STUDIES

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall perform the indicated short circuit and protective device studies for the electrical power system in accordance with the Contract Documents, and provide labels on all electrical equipment as required by the National Electrical Code, state and local regulations.

B. The WORK of this Section shall include protection studies for motors with solid state overload and overcurrent protection devices.

C. It is the responsibility of the CONTRACTOR to obtain the information required from the electric utility and appropriate vendors.

1.2 QUALIFICATIONS

A. Short circuit studies, protective device evaluation studies, arc-flash hazard analysis studies, and protective device coordination studies shall be performed by a firm who has been regularly engaged in short circuit and protective device coordination services for a period of at least 5 years.

B. The indicated studies shall be signed by the professional electrical engineer, registered in the State of Washington, responsible for the studies.

C. The studies shall utilize computer programs with proven reliability and accuracy for performing 3-phase fault-duty calculations.

1.3 CONTRACTOR SUBMITTALS

A. The indicated studies shall be submitted and approved by the ENGINEER prior to final approval of the distribution equipment Shop Drawings and release of equipment for manufacture.

B. An initial short circuit study shall be submitted and reviewed before the ENGINEER will approve the Shop Drawings for 480-volt distribution equipment.

C. Submit an initial protective device coordination study shall be submitted with 90 days after the approval of the initial short circuit study.

D. The short circuit, arc-flash hazard analysis, and protective device coordination studies shall be updated prior to Project Substantial Completion; utilize characteristics of as-installed equipment and materials.

E. The adequacy of the equipment "withstand" and interruption ratings shall be approved by the ENGINEER.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION

3.1 GENERAL

A. The studies shall include development of single-line and impedance diagrams of the power system down to the 120vac panelboard level.

B. The diagrams shall identify components considered in the study and the ratings of power devices, including transformers, circuit breakers, relays, fuses, busses, and cables.

C. The resistances and reactances of cables shall be identified in the impedance diagram.

D. The studies shall contain written data from the electric utility company regarding maximum available short circuit current, voltage, and X/R ratio of the utility power system.

E. The studies shall include every protective device and feeder included or modified within the WORK.

F. The first upstream overcurrent device outside the WORK shall be used as a fixed reference.

G. The studies shall include all portions of the electrical distribution system for normal and standby power sources down to and including the 480-volt distribution system.

3.2 SHORT CIRCUIT STUDY

A. The short circuit study shall be performed with the aid of a digital computer program, and shall be in accordance with the following Standards:

ANSI/IEEE 141	Recommended Practice for Electrical Power Distribution for Industrial Plants
ANSI/IEEE 242	Recommended Practice for Protection, and Coordination of Industrial, and Commercial Power Systems
ANSI/IEEE C 37.010	Application Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis
ANSI/IEEE C 37.13	Low-Voltage AC Power Circuit Breakers Used in Enclosures

3.3 PROTECTIVE DEVICE EVALUATION STUDY

A. A protective device evaluation study shall be performed in order to determine the adequacy of circuit breakers, molded case switches, and fuses.

B. Any problem areas or inadequacies in the equipment due to prospective short-circuit currents shall be promptly brought to the attention of the ENGINEER.

C. Do not utilize series-rated circuit breakers to meet short circuit requirements for this project.

D. Devices shall be fully rated to withstand available fault currents.

3.4 PROTECTIVE DEVICE EVALUATION STUDY

A. A protective device coordination study shall be performed in order to develop the necessary calculations to select power fuse ratings, protective relay characteristics and settings, ratios and characteristics of associated current transformers, and low-voltage breaker trip characteristics and settings.

B. Any problem areas or inadequacies in the equipment due to prospective short-circuit currents shall be promptly brought to the ENGINEER's attention.

3.5 TIME/CURRENT COORDINATION CURVES

A. As a minimum, the time/current coordination curves for the power distribution system shall include the following items plotted on 5-cycle log-log graph paper:

1. time/current curves for each protective relay, circuit breaker, or fuse demonstrating graphically that the settings will provide protection and selectivity within industry standards

2. Each curve shall be identified, and tap and time dial settings shall be specified.

3. Provide individual curves for each feeder unless identical to others.

4. Selectivity

a. Time/current curves for each device shall be positioned to provide the maximum selectivity to minimize system disturbances during fault clearing.

b. Where selectivity cannot be achieved, the ENGINEER shall be notified as to the cause.

c. Recommendations shall be included for alternate methods that would improve selectivity.

5. Time/current curves and points for cable and equipment damage.

6. Circuit interrupting device operating and interrupting times.

7. Indicate maximum fault values on the graph.

8. Sketch of bus and breaker arrangement.

9. Magnetizing inrush points of transformers.

10. Thermal limits of dry-type and liquid-insulated transformers (ANSI damage curve).

11. Every restriction of the ANSI and National Electrical Code shall be followed, and proper coordination intervals and separation of characteristics curves shall be maintained.

3.6 ARC FLASH STUDY

A. An arc flash study shall be performed with the aid of a digital computer program in order to determine the “Arc Flash Protection Boundary” and “Personal Protective Equipment” (PPE) levels for applicable electrical distribution equipment, stand-alone disconnects, starters, and VFDs in the power distribution system.

B. The arc flash study shall be performed in conjunction with short circuit calculations and protective device coordination.

C. The arc flash study shall be in accordance with the latest version of the following Standards:

NFPA 70E	Standard for Electrical Safety Requirements for Employee Workplaces
IEEE 1584	IEEE guide for performing Arc Flash Hazard Calculations
OSHA (29 CFR PART 1910)	Occupational Safety and Health Standards for General Industry
ANSI Z535.4	Product Safety Signs and Labels

D. The recommended values for the “Arc Flash Protection Boundary” and PPE levels, based on the arc flash study results, shall be tabulated in the study.

E. Labeling

1. The digital computer program shall provide the “Arc Flash Protection Boundary” and PPE values in a format that can be directly printed on to labels. **Labels for all equipment shall include all the information listed in NEC Article 110.16(B) to allow workers to select the appropriate PPE in accordance with NFPA 70E.**

2. The CONTRACTOR shall provide these labels in accordance with Section 26 00 00 – Electrical Work, General.

3.7 FINAL SUMMARY REPORT

A. Summarize the results of the indicated power system studies in a final report.

B. The report shall include the following items:

1. single-line diagram

2. impedance diagram

3. tabulation of all protective devices identified on the single line diagram

4. time/current coordination curves

5. specific recommendations, if any

6. test instrumentation, condition, and connections, as applicable, for each study

7. computerized fault current calculations

8. any suggested changes to the protection scheme or equipment selection that will result in improved system reliability and safety

9. recommendations to minimize the arc flash energy

C. The report shall include information concerning the computer program used for the study, as well as a general discussion of the procedure, items, and data considered in the preparation of the study.

D. Submit copies of the report to the ENGINEER.

3.8 PROTECTIVE DEVICE TESTING, CALIBRATION, AND ADJUSTMENT

A. Test, calibrate, and adjust the protective relays and circuit breaker trip devices in accordance with the recommendations in the power system coordination study.

B. Calibrate the MCPs as in accordance with the recommendations in the power system study.

C. Adjustments shall be made prior to energizing any electrical equipment.

END OF SECTION

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SECTION 26 12 16 – PANELBOARDS AND GENERAL-PURPOSE DRY TYPE TRANSFORMERS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide panelboards and general-purpose dry-type transformers, complete and operable, in accordance with the Contract Documents.

B. **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. **General:** Submittals shall be in accordance with Section 01 33 00 - Contractor Submittals and Section 26 00 00 - Electrical Work, General.

B. Shop Drawings

1. Transformers

a. Dimension drawings
b. Technical certification sheets
c. Drawing of conduit entry/exit locations
d. Transformer ratings, including:

1) Voltage
2) Continuous current
3) Basic impulse level for equipment over 600 volts
4) kVA

e. Descriptive bulletins
f. Product sheets

2. Panelboards

a. Breaker layout drawings with dimensions and nameplate designations
b. Component list
c. Drawings of conduit entry/exit locations
d. Assembly ratings including:

1) Short circuit rating
2) Voltage
3) Continuous current

e. Cable terminal sizes
f. Descriptive bulletins
g. Product sheets
h. Installation information

i. Seismic certification and equipment anchorage details

PART 2 -- PRODUCTS

2.1 GENERAL

A. Transformers

1. The transformers shall be dry-type, designed, manufactured, and tested in accordance with the latest applicable standards of ANSI and NEMA.

2. Transformers shall be UL-listed and bear the UL label.

B. Panelboards

1. Panelboards shall be dead front factory assembled. Panelboards shall comply with NEMA PB-1-Panelboards, as well as the provisions of UL 50 - Safety Enclosures for Electrical Equipment and UL 67 - Safety Panelboards. Panelboards used for service equipment shall be UL labeled for such use. Lighting panelboards shall be rated for 120/208 volt, 3 phase operation or 120/240 volt for single phase operation as indicated. Power panelboards shall be rated for 480 volts, 3 phase, 3 wire operation.

2. The manufacturer of the panelboard shall be the manufacturer of the major components within the assembly, including circuit breakers.

2.2 TRANSFORMERS

A. **Energy Efficiency**: Standard dry-type transformers shall meet the energy efficiency requirements of NEMA TP-1 and the Department of Energy Code of Federal Regulations (10 CFR PART 431). The product requirements are in the appliance regulations, Title 20, and the usage requirements are in Title 24.

B. Ratings

1. kVA and voltage ratings shall be as indicated.

2. Transformers shall be designed for continuous operation at rated kVA, for 24 hours a day, 365 days a year operation, with normal life expectancy as defined in ANSI C57.96 - Guide for Loading Dry Type Distribution and Power Transformers

3. Transformer sound levels shall not exceed the following ANSI and NEMA levels for self-cooled ratings:

Up to 9 kVA	40 db
10to50 kVA	45 db
51to150 kVA	50 db

C. Construction

1. Insulation Systems

a. Transformers shall be insulated as follows:

1) 2 kVA and smaller: 150 deg C insulation system based upon 80 deg C rise.

2) 3 to 15 kVA: 185 deg C insulation system based upon 115 deg C rise.

3) 15 kVA and larger: 220 deg C insulation system based upon 150 deg C rise.

b. Required performance shall be obtained without exceeding the above indicated temperature rise in a 40 deg C maximum ambient.

c. Insulation materials shall be flame-retardant and shall not support combustion as defined in ASTM D 635 - Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position.

2. Transformer windings shall be copper.

3. Transformers shall have four 2-1/2 percent taps, 2 above and 2 below 480 volts.

D. **Manufacturers**: Transformers shall be floor or wall-mounted type by **General Electric, Eaton Electrical, Square D,** or equal.

2.3 PANELBOARDS

A. Ratings

1. Panelboards rated 240 VAC or less shall have short circuit ratings not less than 22,000 amperes RMS symmetrical or as indicated by the Contract Drawings, whichever is greater.

2. Panelboards rated 480 VAC shall have short circuit ratings not less than 65,000 amperes RMS symmetrical or as indicated by the Contract Drawings, whichever is greater.

3. Panelboards shall be labeled with a UL short circuit rating. Series ratings are not acceptable.

B. Construction

1. Lighting and power distribution panels shall have copper busbars.

2. Breakers shall be one, 2, or 3 pole as indicated, with ampere trip ratings as required by the equipment. Breakers shall be quick-make and quick-break, inverse time trip characteristics, to trip free on overload or short circuit, and to indicate trip condition by the handle position.

3. The panels shall have hinged doors with combination catch and latch. The front panels shall be so arranged that when the plates are removed, the gutters, terminals and wiring will be exposed and accessible. The doors shall have inner doors within the plates to have only the breaker operating mechanism exposed when they are opened. Live conductors and terminals shall be concealed behind the plates.

4. Panelboards shall be rated for the intended voltage.

5. Circuit breakers shall be interchangeable and capable of being operated in any position as well as being removable from the front of the panelboard without disturbing adjacent units. No plug-in circuit breakers will be acceptable.

6. Lighting and power distribution panels which are not part of a motor control center shall be constructed in accordance with Section 26 00 00. Panels shall have the necessary barriers, supports, and liberal wiring gutters. Trim screws shall be stainless steel. Panelboard parts of metal other than copper, aluminum, or stainless steel shall be cadmium plated. Panelboards shall be as manufactured by **General Electric** or **Eaton Electrical**.

7. Panelboards shall be UL listed except for special enclosures which are not available with UL listing.

8. Panelboards shall be suitable for use as service entrance where indicated.

C. Surge Protective Devices

1. Surge Protective Devices (SPD) shall be designed to provide transient voltage protection for a service entrance panelboard.

2. SPD units shall comply with UL 1449 5th Edition, and shall be listed for such use.

3. Lighting and power distribution panels shall have SPD units installed as part of the panelboard or close-coupled to the panelboard.

4. SPD units shall be rated for the voltage and phase service of the panel at 120 kA per phase or higher as shown.

5. SPD units shall have a built-in diagnostic package with flashing trouble indicator, a display for the status of each phase.

PART 3 -- EXECUTION

3.1 GENERAL

A. WORK of this Section shall be installed as indicated in Section 26 00 00.

END OF SECTION

SECTION 26 50 00 – LIGHTING

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Provide luminaires and accessories, complete and operable, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Codes

NFPA 70	National Electric Code
NEMA 250	Enclosures for Electrical Equipment (1,000 Volts Maximum)
International Building Code (IBC)	Earthquake Requirements
UL-924	Standard for Safety Emergency Lighting and Power Equipment

Standards of the Certified Ballast Manufacturer's Association

1.3 CONTRACTOR SUBMITTALS

A. Furnish the following product information in accordance with the requirements of Section 01 33 00 – Contractor Submittals.

B. Furnish the following information:

1. Exterior Luminaires
   a. catalog data sheets and photos
   b. luminaire finish and metal gauge
   c. lens material, pattern, and thickness
   d. IES lighting classification and isolux diagram
   e. fastening details to wall or pole
   f. for light poles: wind loading; complete dimensions; and finish

2. Lamps
   a. voltages
   b. colors
   c. approximate life (in hours)
   d. approximate initial lumens
   e. lumen maintenance curve

f. lamp type and base

3. Photocells

a. voltage and power consumption

b. capacity

c. contacts and time delay

d. operating levels

e. enclosure type and dimensions

f. temperature range

PART 2 -- PRODUCTS

2.1 LUMINAIRES

A. General

1. Additional WORK requirements are indicated in the Luminaire Schedule on the Drawings.

2. All luminaires shall utilize light emitting diode (LED) lamps.

3. All LED drivers shall be temperature rated for the project location or 40degC (104degF) whichever is higher.

B. Provide a feed-through type or separate junction box.

C. Provide minimum 18 AWG wire leads.

D. Provide components that are accessible and replaceable without removing the luminaire from the ceiling.

E. Exterior Installations

1. Installations shall be UL-labeled as "Suitable for Wet Locations."

2. When factory-installed photocells are provided, the entire assembly shall be UL-labeled.

2.2 LIGHTING CONTROL

A. Switch

1. Each exterior light fixture shall be controlled by an individual light switch in addition to its photocell.

2. Locate switches where shown on the Contract Drawings or as directed by the ENGINEER.

B. Photocell

1. Photo Control: automatic ON-OFF switch

2. Housing where not built into the fixture: self-contained; die-cast aluminum; unaffected by moisture, vibration, or temperature changes

3. Settings: ON at dusk; OFF at dawn

4. Provide a time delay feature in order to prevent false switching.

5. Field-adjustable to control operating levels

6. Manufacturer, or Equal

   a. **Tork**

   b. **Paragon**

2.3 POLES

A. Rating (with luminaire): 100-mph steady winds without incurred damage

B. Material: steel or extruded aluminum

C. Hinged by use of a stainless steel hinge pin

PART 3 -- EXECUTION

3.1 LUMINAIRES

A. General

1. Install in accordance with the manufacturer's recommendations.

2. Provide necessary hangers, pendants, canopies, and other accessories.

3. Provide additional ceiling bracing, hanger supports, and other structural reinforcements to the building and to concrete pole bases as required to safely mount the luminaire.

4. Install the luminaire plumb and level.

5. The mounting heights indicated for wall-mounted or pendant-mounted luminaires are from the bottom of the luminaire to finished floor or finished grade, whichever is applicable.

6. Install each luminaire outlet box with a galvanized stud.

B. Pendant Mounting

1. Provide swivel-type hangers and canopies to match the luminaires, unless otherwise indicated.

2. Space single-stem hangers on continuous-row luminaires 48 inches apart or as recommended by the manufacturer.

3. Provide twin-stem hangers on single luminaires.

C. Pole Mounting

1. Provide a cast-in-place concrete base.

2. Install the pole base flush with the finished grade where located in areas not subject to vehicular traffic, and 30 inches above the finished grade when the pole is located in areas subject to damage from vehicular traffic.

3. Set the luminaire poles on anchor bolts and secure with double nuts on each bolt.

4. After the luminaire has been leveled and plumbed, dry-pack the luminaire base with grout.

3.2 LAMPS

A. Within each luminaire, provide the number and type for which the luminaire is designed, unless otherwise indicated.

3.3 LIGHTING CONTROL

A. Outdoor Luminaires

1. The photocells shall switch lights ON at dusk and OFF at dawn.

B. Dimming Systems

1. Install in accordance with the manufacturer's recommendations.

3.4 CLEAN-UP

A. Remove labels and other markings, except the UL listing mark.

B. Wipe the luminaires inside and out to remove construction dust.

C. Clean the luminaire plastic lenses with an antistatic cleaner only.

D. Touch up painted surfaces of the luminaires and the poles with matching paint provided by the manufacturer.

E. Replace defective lamps at the Date of Substantial Completion.

END OF SECTION

SECTION 31 10 00 - SITE PREPARATION

PART 1 -- GENERAL

1.1 THE SUMMARY

A. In its initial move onto the Site, the CONTRACTOR shall protect existing fences, retaining walls, and associated improvements, parking areas, streets, and utilities downslope of construction areas from damage due to construction activities, boulders, trees, or other objects dislodged during the construction process and clear, grub, strip; and regrade certain areas, in accordance with the Contract Documents.

1.2 SITE INSPECTION

A. Prior to moving onto the Site, the CONTRACTOR shall inspect the Site conditions and review maps of the Site and facilities delineating the OWNER's property and right-of-way lines.

B. All work within the Lower Pond site shall remain within the existing fence limits. Well organized staging may occur outside of the fenceline in locations approved by the OWNER.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION

3.1 SITE ACCESS

A. The CONTRACTOR shall develop any necessary access to the Site, including access barriers to prohibit entry of unauthorized persons.

B. **Utility Interference:** Where existing utilities interfere with the WORK, notify the utility owner and the ENGINEER before proceeding in accordance with the General Conditions.

3.2 CLEARING, GRUBBING, AND STRIPPING

A. Construction areas shall be cleared of grass and weeds to at least a depth of 6-inches and cleared of structures, pavement, sidewalks, concrete or masonry debris, trees, logs, upturned stumps, loose boulders, and any other objectionable material of any kind which would interfere with the performance or completion of the WORK, create a hazard to safety, or impair the subsequent usefulness of the WORK, or obstruct its operation. Loose boulders within 10-feet of the top of cut lines shall be incorporated in landscaping or removed from the Site. Trees and other natural vegetation outside the actual lines of construction shall be protected from damage during construction.

B. Within the limits of clearing, the areas below the natural ground surface shall be grubbed to a depth necessary to remove stumps, roots, buried logs, and other objectionable material. Septic tanks, drain fields, and connection lines and any other underground structures, debris or waste shall be removed if found on the Site. Objectionable material from the clearing and grubbing process shall be removed from the Site and wasted in approved safe locations.

C. Unless otherwise indicated, native trees larger than 6-inches in diameter at the base shall not be removed without the OWNER's approval. The removal of any trees, shrubs, fences, or other improvements outside of rights-of-way, if necessary for the CONTRACTOR's choice of means and methods, shall be arranged with the owner of the property, and shall be removed and replaced, as part of the WORK.

D. For any large trees removed as part of the work, retain the trunk, cut the truck into rounds, and return to the OWNER.

END OF SECTION

SECTION 31 23 19 – DEWATERING

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The Contractor shall dewater trench and structure excavations, in accordance with the Contract Documents.

B. The Contractor shall secure all necessary permits to complete the requirements of this Section of the Specifications.

C. The Contractor shall lower and control groundwater levels and hydrostatic pressures to permit construction work to be performed in the dry in accordance with the Contract Documents. Control of surface water shall be considered as part of the work under this specification.

D. The Contractor shall be responsible for providing all materials, equipment, labor, and services necessary for dewatering in a manner compatible with construction methods and site conditions.

E. The Contractor shall implement an erosion and sedimentation control plan before excavation work begins.

F. Groundwater conditions throughout the Lower Pond work area are described in the Geotechnical Engineering Report 11/2/2023. Groundwater shall be assumed to impact trench and structure excavations. The Contractor shall evaluate and determine actual groundwater conditions of the site and the suitable dewatering systems to be utilized as part of the work.

G. The Tulalip Creek Lower Pond Hatchery is a run-of-river facility within the banks of Tulalip Creek. There is no existing bypass piping for the lower pond dam. Management of the stream flow in Tulalip Creek is critical for construction operations and for maintaining the groundwater table. The Contractor must install the Bypass/Surplus flow pipe from the Flow Splitting Box to the Fish Ladder, Fish Release Pipe, and over the lower dam spillway as a priority for water management. The High Level Outlet flow from the box culvert and aluminum flume must also be controlled at all times during construction and in coordination with the Tribe's operations.

H. Sedimentation tanks (Baker Tanks) are required for all dewatering operations where the discharged water will enter surface waters. The flow rate and turbidity shall be recorded on a daily basis and results submitted to the Owner weekly.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Contractor Submittals.

B. Dewatering Plan

1. Prior to commencement of excavation, the Contractor shall submit a detailed plan and operation schedule for dewatering of excavations and bypass pumping. The detailed plan shall include mitigation measures to prevent settlement of nearby structures such

as the upper and lower dams, and a contingency plan for restoring nearby structures if settlement is observed as a result of the Contractor's dewatering operations. The Contractor may be required to demonstrate the system proposed and to verify that adequate equipment, personnel, and materials are provided to dewater the excavations at all locations and times. The Contractor 's dewatering plan is subject to review by the ENGINEER.

2. The plan shall include the following:

   a. Drawings and data showing the dewatering system, monitoring program, and erosion and sedimentation control plan to be employed.

   b. Detailed description of the dewatering system, including arrangement, location, depth and capacities of the system components, installation details, and operation and maintenance procedures.

   c. Description of the monitoring program, including instrument type, location, installation details, monitoring criteria, and operation and maintenance procedures.

   d. A written report including control procedures to be adopted if dewatering problems arise.

   e. Design calculations demonstrating adequacy of the dewatering system and selected equipment for intended applications.

   f. Description of methods to be employed for disposal of removed water.

C. Temporary Erosion and Sediment Control Plan (TESC) or Surface Water Pollution Prevention Plan (SWPPP)

1. The Contractor shall submit the TESC Plan or SWPPP for review and approval prior to the pre-construction conference.

2. TESC measures, sediment tanks, piping, etc. shown in the TESC Plan or SWPPP may be moved around the site in order to facilitate construction activities, but in all circumstances turbid water shall not leave the construction site and enter surface waters. Significant changes to the TESC measures will require a revised submittal of the TESC Plan or SWPPP.

D. Certified Erosion and Sediment Control Lead (CESCL) Registration

1. The Contractor's SWPPP and TESCs shall be approved by a Washington State or Tulalip Tribes registered CESCL. The CESCL shall make site inspections to verify compliance with the SWPPP.

1.3 QUALITY CONTROL

A. It shall be the sole responsibility of the Contractor to control the rate and effect of the dewatering in such a manner as to avoid all ground settlement and subsidence.

B. All dewatering operations shall be adequate to assure the integrity of the finished project and shall be the responsibility of the Contractor.

C. The dewatering field supervisor shall have a minimum of 5 years of experience related to dewatering work and have completed at least three projects of similar scope and complexity.

PART 2 -- PRODUCTS

2.1 EQUIPMENT

A. Dewatering, where required, may include the use of well points, sump pumps, temporary pipelines for water disposal, rock or gravel placement, and other means. Standby pumping equipment shall be maintained on the Site.

B. Dewatering pumps shall be powered through a temporary construction electrical service. Generators shall be used during power outages with approval by the Owner.

PART 3 -- EXECUTION

3.1 GENERAL REQUIREMENTS

A. During the wet season, the stream flow into the Upper Pond regularly exceeds the capacity of the existing 42” supply pipe and flow splitting box, thereby raising the water surface elevation into a pond. The Contractor is advised that no groundwater dewatering of the Lower Pond site shall occur if the Upper Pond water surface elevation is ponded above stream flow.

B. The Contractor shall coordinate with the Owner to draw down the Upper Pond water surface elevation to stream flow prior to beginning dewatering operations. The Contractor shall verify that the Upper Pond is drawn down to stream flow prior to dewatering.

C. The Owner will need to occasionally fill the Upper Pond for fish rearing activities. Prior to filling the Upper Pond, the Contractor must stop dewatering of the Lower Pond site. The Owner or Engineer will provide three weeks of advance notice to the Contractor when dewatering must be stopped.

D. The Contractor shall provide all equipment necessary for dewatering. It shall have on hand, at all times, sufficient pumping equipment and machinery in good working condition and shall have available, at all times, competent workmen for the operation of the pumping equipment. Adequate standby equipment shall be kept available at all times to insure efficient dewatering and maintenance of dewatering operation during power failure.

E. Install a dewatering system with sufficient capacities to lower and control groundwater level in order to permit excavation, structure construction, and backfilling to be performed in dry conditions. Ensure the dewatering system is adequate to pre-drain water-bearing strata and to maintain groundwater table below the bottom of structure foundations, utilities, and other excavations.

F. Dewatering for structures and pipelines shall commence when groundwater is first encountered, and shall be continuous until such times as water can be allowed to rise in accordance with the provisions of this Section or other requirements. The groundwater table shall be kept at least 24-inches below the subbase of structure or trench excavations.

G. Dewatering shall at all times be conducted in such a manner as to preserve the undisturbed bearing capacity of the subgrade soils at proposed bottom of excavation.

H. If foundation soils are disturbed or loosened by the upward seepage of water or an uncontrolled flow of water, the affected areas shall be excavated and replaced with drain rock or structural fill as required by the Engineer.

I. The Contractor shall maintain the water level below the bottom of excavation in all work areas where groundwater occurs during excavation, construction, and backfilling, until acceptance.

J. Flotation shall be prevented by the Contractor by maintaining a positive and continuous removal of water. The Contractor shall be fully responsible and liable for all damages which may result from failure to adequately keep excavations dewatered.

K. If well points or wells are used, they shall be adequately spaced to provide the necessary dewatering and shall be sandpacked and/or other means used to prevent pumping of fine sands or silts from the subsurface. A continual check by the Contractor shall be maintained to ensure that the subsurface soil is not being removed by the dewatering operation.

L. The Contractor shall dispose of water from the WORK in a suitable manner without damage to adjacent property or negatively impacting surface water or groundwater. Contractor shall be responsible for obtaining any permits that may be necessary to dispose of water.

M. The release of groundwater to its static level shall be performed in such a manner as to maintain the undisturbed state of the natural foundation soils, prevent disturbance of compacted backfill and prevent flotation or movement of new or existing structures, pipelines, and sewers.

N. The Contractor shall utilize all necessary erosion and sediment control measures to avoid construction related degradation of the natural water quality.

O. The Contractor shall implement correction measures if dewatering requirements are not satisfied due to inadequacy or failure of the dewatering system.

P. The Contractor shall immediately repair damages to adjacent facilities caused by dewatering operations.

Q. The Contractor shall remove the dewatering system and monitoring instruments as directed by the Engineer when groundwater control is no longer required. The Contractor shall ensure compliance with all conditions of regulating permits and obtain written approval from the Engineer before discontinuing operation of dewatering system.

R. Dewatering of the nuisance water in trenches and other excavations shall be considered as incidental to the construction of the WORK and all costs thereof shall be included in the various contract prices in the Bid Forms. Dewatering of the groundwater table to maintain 24” of separation from the subbase of trenches and structures is under a separate bid item.

END OF SECTION

SECTION 31 30 00 – EARTHWORK

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall perform earthwork as indicated and required for construction of the WORK, complete and in place, in accordance with the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Submittal Procedures.

B. Aggregate mixes listed on the Washington State Department of Transportation Qualified Products List (QPL) will be approved for use.
   1. https://wsdot.wa.gov/publications/manuals/fulltext/M41-10/Division9.pdf

C. Gradation Analyses

   1. The CONTRACTOR shall submit gradation analyses of materials proposed for the WORK in conformance with the requirements of Section 01 33 00 – Submittal Procedures.

   2. Gradation analyses shall be as determined by a recognized testing laboratory.

D. Testing Laboratory

   1. Qualifications Data: For the testing agency firm and persons specified in the Quality Assurance paragraph to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of Owners and Clients, laboratory certifications and other information.

PART 2 -- PRODUCTS

2.1 FILL AND BACKFILL MATERIAL REQUIREMENTS

A. General

   1. Fill, backfill, and embankment materials shall be selected or shall be processed and clean fine earth, rock, gravel, or sand, free from grass, roots, brush, other vegetation and organic matter.

   2. Fill and backfill materials that are to be placed within 6-inches of any structure or pipe shall be free of rocks or unbroken masses of earth materials having a maximum dimension larger than 3-inches.

B. Suitable Materials

   1. Topsoil is unsuitable as a native subgrade for trenches, pavement, or structures and shall be excavated and removed. Topsoil at this site may extend to 18” in depth and

is identified as loose soil with organic material and dark or reddish coloration in comparison to the native subgrade directly below it.

2. Materials not defined below as unsuitable will be considered as suitable materials and may be used in fills, backfilling, and embankment construction, subject to the indicated requirements.

3. Suitable materials may be obtained from on-Site excavations, may be processed on-Site materials, or may be imported.

4. If imported materials are required by this Section or are required in order to meet the quantity requirements of the WORK, the CONTRACTOR shall provide the imported materials as part of the WORK.

C. The following types of materials are defined:

1. Type A (three-quarters inch minus granular backfill): Crushed rock or gravel, and sand with the gradation requirements below. The material shall have a minimum sand equivalent value of 28 and a minimum R-value of 78. If the sand equivalent value exceeds 35 the R-value requirement is waived.

Sieve Size	Percentage Passing
3/4-inch	100
No. 4	30 - 50
No. 200	0 - 12

2. Type B (Class I crushed stone): Manufactured angular, crushed stone, crushed rock, or crushed slag with the following gradation requirements. The material shall have a minimum sand equivalent value of 75.

Sieve Size	Percentage Passing
3/4-inch	100
No. 4	30 - 50
No. 200	0 - 5

3. Type C (sand backfill): Sand with 100 percent passing a 3/8-inch sieve, at least 90 percent passing a Number 4 sieve, and a sand equivalent value not less than 30.

4. Type D: Not used

5. Type E (pea gravel backfill): Gravel with 100 percent passing a 1/2-inch sieve and not more than 10 percent passing a Number 4 sieve.

6. Type F (coarse drainrock): Crushed rock or gravel meeting the following gradation requirements:

Sieve Size	Percentage Passing
2-inch	100
1-1/2 inch	90 - 100
1-inch	20 - 55
3/4-inch	1 - 15
No. 200	0 - 3

7. Type G (aggregate base): Crushed rock aggregate base material of such nature that it can be compacted readily by watering and rolling to form a firm, stable base for pavements. At the option of the CONTRACTOR, the grading for either the 1-1/2 inch maximum size or 3/4-inch maximum size gradation shall be used. The sand equivalent value shall be not less than 22, and the material shall meet the following gradation requirements:

	Percentage Passing	
Sieve Size	**1-1/2 inch Max Gradation**	**3/4-inch Max Gradation**
2-inch	100	-
1-1/2-inch	90 - 100	-
1-inch	-	100
3/4-inch	50 - 85	90 – 100
No. 4	25 - 45	35 – 55
No. 30	10 - 25	10 – 30
No. 200	2 - 9	2 – 9

8. Type H (graded drain rock): Drain rock shall be crushed rock or gravel, durable and free from slaking or decomposition under the action of alternate wetting or drying. The material shall be uniformly graded and shall meet the following gradation requirements:

Sieve Size	Percentage Passing
1-inch	100
3/4-inch	90 – 100
3/8-inch	40 – 100
No. 4	25 – 40
No. 8	18 – 33
No. 30	5 – 15
No. 50	0 – 7
No. 200	0 – 3

9. Type I: Any other suitable material as defined herein.

10. Type J (cement-treated backfill): Material which consists of Type H material, or any mixture of Types B, C, G, and H materials which has been cement-treated so that the cement content of the material is not less than 5 percent by weight when tested in accordance with ASTM D 2901 - Standard Test Method for Cement Content of Freshly Mixed Soil Cement. The ultimate compressive strength at 28 days shall be not less than 400 psi when tested in accordance with ASTM D 1633 - Standard Test Method for Compressive Strength of Molded Soil - Cement Cylinders.

11. Type K (topsoil): Stockpiled native topsoil material which has been obtained at the Site by removing soil to a depth not exceeding 12 inches. Removal of the topsoil shall be done after the area has been stripped of vegetation and debris. See Section 31 35 28 for top soil protection measures after installation and during temporary stockpiling and storage.

12. Type L (controlled low strength material): Controlled low strength material also known as Controlled Density Fill (CDF) shall be in accordance with Section 03 30 10 Controlled Density Fill and WSDOT Specification 2-09.3(1)E

13. Type M (aggregate subbase): Crushed rock aggregate subbase material that can be compacted readily by watering and rolling to form a firm stable base. The sand equivalent value shall be not less than 18 and the material shall meet the following gradation requirements:

Sieve Size	Percentage Passing
3-inch	100
2-1/2 inch	87 - 100
No. 4	35 - 95

No. 200	0 - 29

14. Crushed Surfacing Base Course (CSBC): Washington State Department of Transportation (WSDOT) Specification 9-03.9(3) Crushed rock aggregate mix that shall be used for foundation subbase and roadway subbase.

15. Crushed Surfacing Top Course (CSTC): Washington State Department of Transportation (WSDOT) 9-03.9(3) crushed rock aggregate mix that shall be used as the intermediate layer between CSBC and Hot Mix Asphalt in roadway base preparation.

16. Gravel Backfill for Drains: WSDOT 9-03.12(4) drain rock aggregate mix that shall be used for as the bedding, haunching, and trench backfill for under drain pipe and shall be used in other applications that require Type H aggregate.

17. Gravel Backfill for Pipe Zone Bedding: WSDOT 9-03.12(3) aggregate mix used for bedding and haunches when installing flexible pipe. Not required for pipe trenches where concrete encasement is required or for under drain pipe.

18. Bank Run Gravel For Trench Zone Backfill: WSDOT 9-03.19 shall be used for backfill of pipe trenches above the pipe bedding zone, except where concrete encasement is required, CDF backfill, or for under drain pipe trenches.

19. Gravel Borrow: WSDOT Specification 9-03.14(1) granular aggregate either naturally occurring or processed for use in backfilling around structures and raising the grade in preparation for trench bedding, or paving and structures subbase installation.

20. Quarry Spalls: Broken processed rock. The use of recycled materials and concrete rubble is not permitted for this application.

    Quarry spalls shall meet the following requirements for grading:

Sieve Size	**Percentage Passing**
4 inch	100
2 inch	40
¾ inch	10 max.

21. Soil: Soils which, when classified under ASTM D 2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System), fall in the classifications of Pt, OH, CH, MH, or OL shall be classified as unsuitable.

22. Quarry Produced Boulders: Quarry produced boulders shall be hard, sound and durable material, free from seams, cracks, and other defects tending to destroy its resistance to weather. Quarry produced boulders shall be angular in shape and the

thickness axis shall be greater than 60 percent of the length axis. Quarry produced boulders sizes are approximately as follows, see Plans for sizes specified:

Boulder Size	Approximate Size
1 – Man Boulder	12” – 18”
2 – Man Boulder	18” – 28”
3 – Man Boulder	28” – 36”
4 – Man Boulder	36” – 48”
5 – Man Boulder	48” – 54”
6 – Man Boulder	54” – 60”

[1]Approximate Size can be determined by taking the average dimension of the three axes of the boulder, Length, Width, and Thickness, by use of the following calculation:

$$\frac{\text{Length} + \text{Width} + \text{Thickness}}{3} = \text{Approximate Size}^{1}$$

Length is the longest axis, width is the second longest axis, and thickness is the shortest axis.

D. Schedule: Aggregate materials shall be used as indicated below:

Flexible Pipe	Aggregate Material
Pipe zone bedding	Gravel Backfill for Pipe Zone Bedding
Trench zone backfill	Bank Run Gravel for Trench Zone Backfill
General Site Backfill	**Aggregate Material**
Final backfill unpaved areas	K, (Topsoil)
Trench, paving and structure backfill to prepare pipe bedding or subbase layer	Gravel Borrow
Asphalt Paving	**Aggregate Material**
Aggregate base material	CSTC
Aggregate subbase	CSBC
Concrete Structures	**Aggregate Material**
Backfill around structures	Gravel Borrow
Under hydraulic or water retaining structures with underdrains	Gravel Backfill for Drains

Aggregate base	CSBC
Retaining Walls	**Aggregate Material**
Rock backfill	Quarry Spalls
Underdrain pipe system gravel	Gravel Backfill for Drains
Intertidal Holding Pool	**Aggregate Material**
Intertidal Pool Fill	3 – Man Boulder
Beach Nourishment	Rounded 2” minus gravel mix

2.2 MATERIALS TESTING

A. Samples

1. Soils testing of samples submitted by the CONTRACTOR will be performed by a testing laboratory of the OWNER's choice and at the CONTRACTOR’s expense.

2. The ENGINEER may direct the CONTRACTOR to supply samples for testing of any material used in the WORK.

B. Particle size analysis of soils and aggregates will be performed using ASTM D 422 - Standard Test Method for Particle-Size Analysis of Soils.

C. Determination of sand equivalent value will be performed using ASTM D 2419 - Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate.

D. Unified Soil Classification System

1. References in this Section to soil classification types and standards shall have the meanings and definitions indicated in ASTM D 2487.

2. The CONTRACTOR shall be bound by applicable provisions of ASTM D 2487 in the interpretation of soil classifications.

2.3 IDENTIFICATION TAPE

A. Unless otherwise indicated, identification tape shall be placed above buried pipelines that are not comprised of magnetic components at least in part.

B. Identification tape shall be 6-inches wide, yellow in color, composed of polyethylene, and provided with an integral metallic wire.

C. Tape shall be labeled with CAUTION – BURIED UTILITIES.

PART 3 -- EXECUTION

3.1 EXCAVATION AND BACKFILLING - GENERAL

A. General

1. Except when specifically provided to the contrary, excavation shall include the removal of materials, including obstructions, that would interfere with the proper execution and completion of the WORK.

2. The removal of such materials shall conform to the lines and grades indicated or ordered.

3. Unless otherwise indicated, the entire Site shall be stripped of vegetation and debris and shall be grubbed, and such material shall be removed from the Site prior to performing any excavation or placing any fill.

4. The CONTRACTOR shall furnish, place, and maintain supports and shoring that may be required for the sides of excavations.

5. Excavations shall be sloped or otherwise supported in a safe manner in accordance with applicable state safety requirements and the requirements of OSHA Safety and Health Standards for Construction (29CFR1926).

6. The CONTRACTOR shall provide quantity surveys where so required to verify quantities for Unit Price Contracts.

7. Surveys shall be performed prior to beginning WORK and upon completion by a surveyor licensed in the state where the Site is located.

B. Removal and Exclusion of Water

1. The CONTRACTOR shall remove and exclude water, including stormwater, groundwater, irrigation water, and wastewater, from excavations.

2. Dewatering wells, wellpoints, sump pumps, or other means shall be used to remove water and continuously maintain groundwater at a level at least 2 feet below the bottom of excavations before the excavation WORK begins at each location.

3. Water shall be removed and excluded until backfilling is complete and field soils testing has been completed.

3.2 OVER-EXCAVATION

A. Indicated

1. Where areas are indicated to be over-excavated, excavation shall be to the depth indicated, and backfill shall be installed to the grade indicated.

B. Not Indicated

1. When ordered to over-excavate areas deeper and/or wider than required by the Contract Documents, the CONTRACTOR shall over-excavate to the dimensions ordered and backfill to the indicated grade.

C. Neither Indicated nor Ordered

1. Any over-excavation carried below the grade that is neither ordered or nor indicated shall be backfilled and compacted to the required grade with the indicated material as part of the WORK

3.3 DISPOSAL OF EXCESS EXCAVATED MATERIAL

A. Unless otherwise indicated, excess excavated material shall be the property of the CONTRACTOR.

B. The CONTRACTOR shall be responsible for the removal and disposal of excess excavated material.

C. Material shall be disposed of at an approved on-Site disposal area or off-Site at a location arranged by the CONTRACTOR in accordance with laws and regulations regarding the disposal of such material.

3.4 BACKFILL

A. General

1. Backfill shall not be dropped directly upon any structure or pipe.

2. Backfill shall not be placed around or upon any structure until the concrete has attained sufficient strength to withstand the loads imposed.

3. Backfill around water-retaining structures shall not be placed until the structures have been tested, and the structures shall be full of water while backfill is being placed.

B. Except for drainrock materials being placed in over-excavated areas or trenches, backfill shall be placed after water is removed from the excavation and the trench sidewalls and bottom have been dried to a moisture content suitable for compaction.

C. Pre-Placement Conditions

1. Immediately prior to placement of backfill materials, the bottoms and sidewalls of trenches and structure excavations shall have any loose, sloughing, or caving soil and rock materials removed.

2. Trench sidewalls shall consist of excavated surfaces that are in a relatively undisturbed condition before placement of backfill materials.

D. Layering

1. Backfill materials shall be placed and spread evenly in layers.

2. When compaction is achieved using mechanical equipment, the layers shall be evenly spread such that when compacted each layer shall not exceed 6 inches in thickness.

E. During spreading, each layer shall be thoroughly mixed as necessary in order to promote uniformity of material in each layer.

F. Moisture Content

1. Where the backfill material moisture content is below the optimum moisture content, water shall be added before or during spreading until the proper moisture content is achieved. Contractor shall mix aggregate piles after watering to redistribute the smaller material washed down into the pile.

2. Where the backfill material moisture content is too high to permit the indicated degree of compaction, the material shall be dried until the moisture content is satisfactory.

3.5 STRUCTURE, ROADWAY, AND EMBANKMENT EXCAVATION AND BACKFILL

A. Excavation Beneath Structures and Embankments

1. Except where indicated otherwise for a particular structure or where ordered by the ENGINEER, excavation shall be carried to an elevation 6 inches below the bottom of the footing or slab and brought back to grade with compacted materials acceptable for placement beneath structures.

2. Where indicated or ordered, areas beneath structures or fills shall be over-excavated.

3. When such over-excavation is indicated, both the over-excavation and the subsequent backfill to the required grade shall be performed by the CONTRACTOR.

4. After the required excavation or over-excavation for fills and embankments has been completed, the exposed surface shall be scarified to a depth of 6 inches, brought to optimum moisture content, and rolled with heavy compaction equipment to obtain 95 percent of maximum density.

B. Excavation Beneath Paved Areas

1. Excavation under areas to be paved shall extend to the bottom of the aggregate base or subbase, if such base is called for; otherwise it shall extend to the paving thickness.

2. After the required excavation has been completed, the top 12-inches of exposed surface shall be scarified, brought to optimum moisture content, and rolled with heavy compaction equipment to obtain 95 percent of maximum density.

3. The finished subgrade shall be even, self-draining, and in conformance with the slope of the finished pavement.

4. Areas that could accumulate standing water shall be regraded to provide a self-draining subgrade.

C. Notification of OWNER

1. The CONTRACTOR shall notify the OWNER at least 3 Days in advance of completion of any structure or roadway excavation and shall allow the ENGINEER a review

period of at least one day before the exposed foundation is scarified and compacted or is covered with backfill or with any construction materials.

D. Compaction of Fill, Backfill, and Embankment Materials

1. Each layer of backfill materials as defined herein, where the material is graded such that 10 percent or more passes a No. 4 sieve, shall be mechanically compacted to the indicated percentage of density. Non-structural backfill shall be compacted equal or greater than 93% of Maximum Dry Density (MDD). Structural backfill shall be compacted to equal or greater than 98% of the MDD.

2. Equipment that is consistently capable of achieving the required degree of compaction shall be used, and each layer shall be compacted over its entire area while the material is at the required moisture content.

3. Each layer of coarse granular backfill materials with less than 10 percent passing the No. 4 sieve shall be compacted by means of at least 2 passes from a vibratory compactor that is capable of obtaining the required density in 2 passes.

E. Heavy Equipment

1. Equipment weighing more than 10,000 pounds shall not be used closer to walls than a horizontal distance equal to the vertical depth of the fill above undisturbed soil at that time.

2. Hand-operated power compaction equipment shall be used where the use of heavier equipment is impractical or restricted due to weight limitations.

F. Layering

1. Embankment and fill material shall be placed and spread evenly in approximately horizontal layers.

2. Each layer shall be moistened and aerated as necessary.

3. Unless otherwise approved by the ENGINEER, no layer shall exceed 6 inches of compacted thickness.

4. The embankment and fill shall be compacted in conformance with Paragraph K, below.

G. Embankments and Fills

1. When an embankment or fill is to be constructed and compacted against hillsides or fill slopes steeper than 4:1, the slopes of the hillsides or fills shall be horizontally benched in order to key the embankment or fill to the underlying ground.

2. A minimum of 12 inches perpendicular to the slope of the hillside or fill shall be removed and re-compacted as the embankment or fill is brought up in layers.

3. Material thus cut shall be re-compacted along with the new material.

4. Hillside or fill slopes 4:1 or flatter shall be prepared in accordance with Paragraph A, above.

H. Compaction Requirements

1. The following compaction requirements shall be in accordance with ASTM D 1557 - Test Method for Laboratory Compaction Characteristics of Soils Using Modified Effort (56,000 ft - lbf/ft^3) (2,700 kN-m/m^3) where the material is graded such that 10 percent or more passes a No. 4 sieve and in accordance with ASTM D 4253 - Test Method for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table, and D 4254 - Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density, where the material is coarse granular backfill materials with less than 10 percent passing the No. 4 sieve:

Location or Use of Fill or Backfill	Percentage of Maximum Dry Density	Percentage of Relative Density
Embankments and fills not identified otherwise	90	55
Embankments and fills beneath paved areas or structures	95	70
Backfill beneath structures and hydraulic structures	95	70
Topsoil	80	NA
Aggregate base or subbase	95	NA

3.6 PIPELINE AND UTILITY TRENCH EXCAVATION AND BACKFILL

A. General

1. Unless otherwise indicated or ordered, excavation for pipelines and utilities shall be open-cut trenches with minimum widths as indicated on the drawings.

B. Trench Bottom

1. Except where pipe bedding is required, the bottom of the trench shall be excavated uniformly to the grade of the bottom of the pipe.

2. Excavations for pipe bells and welding shall be made as required.

3. Where pipe bedding is required, the bottom of the trench shall be excavated uniformly to the grade of the bottom of the pipe bedding.

C. Open Trenches

1. The maximum amount of open trench permitted in any one location shall be 500 feet or the length necessary to accommodate the amount of pipe installed in a single Day, whichever is greater.

2. Trenches shall be fully backfilled at the end of each Day or, in lieu thereof, shall be covered by heavy steel plates adequately braced and capable of supporting vehicular traffic in those locations where it is impractical to backfill at the end of each Day.

3. These requirements for backfilling or use of steel plate will be waived in cases where the trench is located further than 100 feet from any traveled roadway or occupied structure; in such cases, however, barricades and warning lights meeting appropriate safety requirements shall be provided and maintained.

D. Trench Shield

1. If a moveable trench shield is used during excavation operations, the trench width shall be wider than the shield such that the shield is free to be lifted and then moved horizontally without binding against the trench sidewalls and causing sloughing or caving of the trench walls.

2. If the trench walls cave or slough, the trench shall be excavated as an open excavation with sloped sidewalls or with trench shoring, as indicated and as required by the pipe structural design.

3. If a moveable trench shield is used during excavation, pipe installation, and backfill operations, the shield shall be moved by lifting the shield free of the trench bottom or backfill and then moving the shield horizontally.

4. The CONTRACTOR shall not drag trench shields along the trench causing damage or displacement to the trench sidewalls, the pipe, or the bedding and backfill.

E. Placing and Spreading Of Backfill Materials

1. Each layer of coarse granular backfill materials with less than 10 percent passing the No. 4 sieve shall be compacted by means of at least 2 passes from a vibratory compactor that is capable of achieving the required density in 2 passes and that is acceptable to the ENGINEER.

2. Where such materials are used for pipe zone backfill, vibratory compaction shall be used at vertical intervals of the lesser of:

   a. one-half the diameter of the pipe; or

   b. 24-inches, measured in the uncompacted state.

3. In addition, these materials shall be subjected to vibratory compaction at the springline of the pipe and the top of the pipe zone backfill, regardless of whether that dimension is less than 24-inches or not.

4. Each layer of backfill material with greater than 10 percent passing the No. 4 sieve shall be compacted using mechanical compactors suitable for the WORK.

5. The material shall be placed and compacted under the haunch of the pipe and up each side evenly so as not to move the pipe during the placement of the backfill.

6. The material shall be placed in lifts that will not exceed 6-inches when compacted to the required density.

F. Mechanical Compaction

1. Backfill around and over pipelines that is mechanically compacted shall be compacted using light, hand-operated vibratory compactors and rollers that do not damage the pipe.

2. After completion of at least 2 feet of compacted backfill over the top of pipeline, compaction equipment weighing no more than 8,000 pounds may be used to complete the trench backfill.

G. Pipe And Utility Trench Backfill

1. Pipe Zone Backfill

a. Definitions

1) The pipe zone is defined as that portion of the vertical trench cross-section lying between a plane below the bottom surface of the pipe and a plane at a point above the top surface of the pipe as indicated on the drawings.

2) The bedding is defined as that portion of pipe zone backfill material between the trench subgrade and the bottom of the pipe.

3) The embedment is defined as that portion of the pipe zone backfill material between the bedding and a level line as indicated.

b. Final Trim

1) After compacting the bedding, the CONTRACTOR shall perform a final trim using a stringline for establishing grade, such that each pipe section when first laid will be continually in contact with the bedding along the extreme bottom of the pipe.

2) Excavation for pipe bells and welding shall be made as required.

c. The pipe zone shall be backfilled with the indicated backfill material.

d. Pipe zone backfill materials shall be manually spread evenly around the pipe and “knifed” into the haunches on both sides of the pipe using a shovel for the full length, while maintaining the same height on both sides of the pipe such that when compacted the pipe zone backfill will provide uniform bearing and side support.

e. The CONTRACTOR shall exercise care in order to prevent damage to the pipeline coating, cathodic bonds, and the pipe itself during the installation and backfill operations.

2. Trench Zone Backfill

    a. After the pipe zone backfill has been placed, backfilling of the trench zone may proceed.

    b. The trench zone is defined as that portion of the vertical trench cross-section lying as indicated between a plane above the top surface of the pipe and a plane at a point 18-inches below the finished surface grade, or if the trench is under pavement, 18-inches below the roadway subgrade.

3. Final Backfill

    a. Final backfill is defined as backfill in the trench cross-sectional area within 18-inches of finished grade, or if the trench is under pavement, backfill within 18-inches of the roadway subgrade.

H. Identification Tape/ Locating Wire

1. Install identification tape and/or locating wire as indicated.

2. Terminate the tape and/or in a precast concrete box either adjacent to or part of the valve box, manhole, vault, or other structure into which the non-metallic pipe enters or at the end of the non-metallic pipeline.

3. Install locating wire 6-inches directly above non-metallic pipe. Wire connections/splices shall not be made in the trench. All splices must be made in structures such as a concrete box, valve box, manhole, vault, etc. where they can be viewed from grade. When a splice is required mid-run along the pipe, the locating wire ends shall be extended upward from the pipe alignment to the box located at grade, where the splice is made.

4. Locating wire shall be 14 gauge solid copper with neoprene coating. Splices shall be made using weather proof under ground wire connectors.

5. The termination box shall be covered with a cast iron lid.

6. The box shall be located at grade in paved areas or 6-inches above grade in unpaved areas.

I. Trench Shield

1. If a moveable trench shield is used during backfill operations, the shield shall be lifted to a location above each layer of backfill material prior to compaction of the layer.

2. The CONTRACTOR shall not displace the pipe or backfill while the shield is being moved.

J. Compaction Requirements

1. The following compaction test requirements shall be in accordance with ASTM D 1557 - Test Method for Laboratory Compaction Characteristics of Soils Using Modified Effort (56,000 ft - lbf/ft^3) (2,700 kN-m/m^3) where the material is graded such that 10 percent or more passes a No. 4 sieve, and in accordance with ASTM D 4253 -

Standard Test Method for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table, and D 4254 - Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density where the material is coarse granular backfill materials with less than 10 percent passing the No. 4 sieve.

Location or Use of Fill or Backfill	Percentage of Maximum Dry Density	Percentage of Relative Density
Pipe embedment backfill for flexible pipe.	95	70
Pipe bedding and over-excavated zones under bedding for flexible pipe, including trench plugs.	95	70
Pipe zone backfill portion above embedment for flexible pipe	95	70
Pipe embedment backfill for rigid pipe	90	55
Pipe zone backfill portion above embedment for rigid pipe.	95	70
Pipe bedding and over-excavated zones under bedding for rigid pipe.	95	70
Final backfill, beneath paved areas or structures.	95	70
Final backfill, not beneath paved areas or structures.	90	55
Trench zone backfill, beneath paved areas and structures, including trench plugs.	95	70
Trench zone backfill, not beneath paved areas or structures, including trench plugs.	95	70

3.7 FIELD TESTING

A. General:

1. Field soils testing was performed at the five locations shown in the Geotechnical Baseline Report.

B. Density

1. Where soil material is required to be compacted to a percentage of maximum density, the maximum density at optimum moisture content will be determined in accordance with Method C of ASTM D 1557.

2. Where cohesionless, free draining soil material is required to be compacted to a percentage of relative density, the calculation of relative density will be determined in accordance with ASTM D 4253 and D 4254.

3. Field density in-place tests will be performed in accordance with ASTM D 1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method, ASTM D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place By Nuclear Methods (Shallow Depth), or by such other means acceptable to the ENGINEER.

C. Remediation

1. In case the test of the fill or backfill shows non-compliance with the required density, the CONTRACTOR shall accomplish such remedy as may be required to ensure compliance.

2. Subsequent testing to show compliance shall be by a testing laboratory selected by the OWNER and paid by the CONTRACTOR.

D. CONTRACTOR's Responsibilities

1. The trenches and excavations shall be provided at the locations and to the depths as required by the OWNER.

END OF SECTION

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SECTION 31 34 19 – GEOTEXTILES

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide geotextiles, complete and in place, in accordance with the Contract Documents.

B. Definitions: The following definitions apply to the WORK of this Section:

1. Fabric: Geotextile, a permeable geosynthetic comprised solely of textiles.

2. Minimum Average Roll Value (MinARV): Minimum of series of average roll values representative of geotextile provided.

3. Maximum Average Roll Value (MaxARV): Maximum of series of average roll values representative of geotextile provided.

4. Nondestructive Sample: Sample representative of finished geotextile, prepared for testing without destruction of geotextile.

5. Overlap: Distance measured perpendicular from overlapping edge of one sheet to underlying edge of adjacent sheet.

6. Seam Efficiency: Ratio of tensile strength across seam to strength of intact geotextile, when tested according to ASTM D 4884.

7. Woven geotextile: A geotextile fabric composed of polymeric yarn interlaced to form a planar structure with uniform weave pattern.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. The following standards are referenced in this Section:

ASTM D 4355	Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture, and Heat in a Xenon-Arc Type Apparatus
ASTM D 4491	Standard Test Methods for Water Permeability of Geotextiles by Permittivity
ASTM D 4533	Standard Test Method for Trapezoid Tearing Strength of Geotextiles
ASTM D 4595	Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method
ASTM D 4751	Standard Test Method for Determining Apparent Opening Size of a Geotextile
ASTM D 4833	Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products

ASTM D 4884	Standard Test Method for Strength of Sewn or Thermally Bonded Seams of Sewn Geotextiles
ASTM D 4886	Standard Test Method for Abrasion Resistance of Geotextiles (Sand Paper/Sliding Block Method)

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals.

B. Shop Drawings

1. Manufacturer material specifications and product literature.

2. Installation drawings showing geotextile sheet layout, location of seams, direction of overlap, and sewn seams.

3. Description of proposed method of geotextile deployment, sewing equipment, sewing methods, and provisions for holding geotextile temporarily in place until permanently secured.

C. Samples

1. Geotextile: One-piece, minimum 18-inches long, taken across full width of roll of each type and weight of geotextile. Label each with brand name and furnish documentation of lot and roll number from which each sample was obtained.

2. Field Sewn Seam: 5-foot length of seam, 12-inches wide with seam along center, for each type and weight of geotextile.

3. Securing Pin/Nail and Washer: 1 each.

D. Certifications

1. Certification from geotextile manufacturer that products satisfy the indicated requirements.

2. Field seam efficiency test results.

PART 2 -- PRODUCTS

2.1 NONWOVEN GEOTEXTILE

A. Nonwoven geotextile shall be composed of a pervious sheet of polymeric fibers interlaced to form a planar structure with uniform random fiber pattern. Products shall be calendared or finished so that yarns will retain their relative position with respect to each other.

B. Polymeric yarn shall be long-chain synthetic polymers (polyester, polypropylene, or polyethylene) with stabilizers or inhibitors added to make filaments resistant to deterioration due to heat and ultraviolet light exposure.

C. Geotextile Edges: Selvaged or finished to prevent outer material from separating from sheet.

D. Unseamed Sheet Width: Minimum 6-feet.

E. Nominal Weight per Square Yard: 12 ounces.

F. Physical Properties: Conform to requirements below.

PHYSICAL PROPERTY REQUIREMENTS FOR NONWOVEN GEOTEXTILE		
Property	Requirement	Test Method
Apparent Opening Size (AOS)	No. 100 to No. 140 U.S. Standard Sieve Size	ASTM D 4751
Water Permittivity	1.2 $sec.^{-1}$, MinARV	ASTM D 4491 (Falling Head)
Vertical Waterflow Rate	90 gpm/sq ft, MinARV	
Wide Width Strip Tensile Strength	300 MinARV	ASTM D 4595
Wide Width Strip Elongation	70 percent, MaxARV	ASTM D 4595
Trapezoidal Tear Strength	120 lb, MinARV	ASTM D 4533
Puncture Strength	130 lb, MinARV	ASTM D 4833
Ultraviolet Radiation Resistance	90 percent strength retention, MinARV after 500 hours	ASTM D 4355

2.2 SEWING THREAD

A. Sewing thread shall be polypropylene, polyester, or Kevlar thread with durability equal to or greater than durability of geotextile sewn.

2.3 SECURING PINS/NAILS

A. Securing pins shall be steel rods or bars conforming to the following:

1. 3/16-inch diameter.

2. Pointed at one end; head on other end, sufficiently large to retain washer.

3. Minimum Length: 12-inches.

B. Steel washers for securing pins shall be:

1. Outside Diameter: Not less than 1-1/2 inches.

2. Inside Diameter: 1/4-inch.

3. Thickness: 1/8-inch.

C. Steel Wire Staples

1. U-shaped.

2. 10-gauge.

3. Minimum 6-inches long.

PART 3 -- EXECUTION

3.1 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver each roll with sufficient information attached to identify manufacturer and product name or number.

B. Handle products in manner that maintains undamaged condition.

C. Do not store products directly on ground. Ship and store geotextile with suitable wrapping for protection against moisture and ultraviolet exposure. Store geotextile in a way that protects it from elements. If stored outdoors, elevate and protect geotextile with waterproof cover.

3.2 LAYING GEOTEXTILE

A. Notify the ENGINEER whenever geotextiles are to be placed. Do not place geotextile prior to obtaining ENGINEER's approval of underlying materials.

B. Lay and maintain geotextile smooth and free of tension, folds, wrinkles, or creases.

3.3 ORIENTATION ON SLOPES

A. Orient geotextile with long dimension of each sheet parallel to direction of slope.

B. Geotextile may be oriented with long dimension of sheet transverse to direction of slope only if sheet width, without unsewn seams, is sufficient to cover entire slope and anchor trench and extend at least 18-inches beyond toe of slope.

3.4 JOINTS

A. Unseamed Joints

1. Unseamed joints shall be overlapped to the following dimensions unless otherwise indicated:

a. Foundation/Subgrade Stabilization: Minimum 18-inches.

b. Riprap: Minimum 18-inches.

c. Drain Trenches: Minimum 18-inches, except overlap shall equal trench width if trench width is less than 18-inches.

d. Other Applications: Minimum 12-inches.

B. Sewn seams shall be used wherever stress transfer from one geotextile sheet to another is necessary. Sewn seams, as approved by ENGINEER, also may be used instead of overlap at joints for applications that do not require stress transfer.

1. Seam efficiency shall be minimum 70 percent, verified by preparing and testing minimum of one set of nondestructive samples per acre of each type and weight of geotextile provided. Test according to ASTM D 4884.

2. Type: "J" type seams are preferred, but flat or butterfly seams are acceptable.

3. Stitch Count: Minimum 3 to maximum 7 stitches per inch.

4. Stitch Type: Double-thread chainstitch, Type 401, Federal Standard No. 751a.

5. Stitch Location: 2-inches from geotextile sheet edges, or more if necessary to develop required seam strength.

6. Sewing Machines: Capable of penetrating 4 layers of geotextile.

3.5 SECURING GEOTEXTILE

A. Secure geotextile during installation as necessary with sand bags or other means approved by ENGINEER.

B. Securing Pins

1. Insert securing pins with washers through geotextile, midway between edges of overlaps and 6-inches from free edges.

2. Spacing

Slope	Maximum Pin Spacing, feet
Steeper than 3:1	2
3:1 to 4:1	3
Flatter than 4:1	5

3. Install additional pins across each geotextile sheet as necessary to prevent slippage of geotextile or to prevent wind from blowing geotextile out of position.

4. Push each securing pin through geotextile until washer bears against geotextile and secures it firmly to subgrade.

3.6 PLACING PRODUCTS OVER GEOTEXTILE

A. Notify ENGINEER before placing material over geotextile,. Do not cover installed geotextile prior to receiving authorization from the ENGINEER to proceed.

B. If tears, punctures, or other geotextile damage occurs during placement of overlying products, remove overlying products as necessary to expose damaged geotextile. Repair damage as indicated below.

3.7 INSTALLING GEOTEXTILE IN TRENCHES

A. Place geotextile in a way that will completely envelope granular drain material to be placed in trench and with indicated overlap at joints. Overlap geotextile in direction of flow. Place geotextile in a way and with sufficient slack for geotextile to contact trench bottom and sides fully when trench is backfilled.

B. After granular drain material is placed to grade, fold geotextile over top of granular drain material, unless otherwise indicated. Maintain overlap until overlying fill or backfill is placed.

3.8 SILT FENCE APPLICATIONS

A. Install geotextile in one piece or continuously sewn to make one piece, for full length and height of fence, including portion of geotextile buried in toe trench.

B. Install bottom edge of sheet in toe trench and backfill in a way that securely anchors geotextile in trench.

C. Securely fasten geotextile to a wire mesh backing and each support post in a way that will not result in tearing of geotextile when fence is subjected to service loads.

D. Promptly repair or replace silt fence that becomes damaged.

3.9 REPAIRING GEOTEXTILE

A. Repair or replace torn, punctured, flawed, deteriorated, or otherwise damaged geotextile. Repair damaged geotextile by placing patch of undamaged geotextile over damaged area plus at least 18-inches in all directions beyond damaged area. Remove interfering material as necessary to expose damaged geotextile for repair. Sew patches or secure them with pins and washers, as indicated above for securing geotextile, or by other means approved by ENGINEER.

3.10 REPLACING CONTAMINATED GEOTEXTILE

A. Protect geotextile from contamination that would interfere, in ENGINEER's opinion, with its intended function. Remove and replace contaminated geotextile with clean geotextile.

END OF SECTION

SECTION 31 35 28 - EROSION CONTROL (VEGETATIVE)

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide erosion protection including fertilizing, compost application, seeding, and mulching for all disturbed areas that are not to be paved or otherwise treated in accordance with the Contract Documents.

PART 2 -- PRODUCTS

2.1 MATERIALS

A. **Fertilizer:** Erosion control fertilizer (WSDOT 9-14.4) shall be a commercial, chemical type, uniform in composition, free flowing, conforming to state and federal laws and suitable for application with equipment designed for that purpose. Fertilizer shall have a guaranteed analysis showing not less than 11 percent nitrogen, 8 percent available phosphoric acid, and 4 percent water soluble potash.

B. **Compost:** The use of Fine Compost (WSDOT 9-14.5(8)) applied in a depth of 4-inches shall be mixed into the topsoil with the fertilizer.

C. **Seed:** Seed shall be delivered in original unopened packages bearing an analysis of the contents. Seed shall be guaranteed 95 percent pure with a minimum germination rate of 80 percent.

1. Seed mix (WSDOT 9-14.3) shall be suited to Western Washington and be a mix of fast growing annual and perennial grasses native to low land Puget Sound area. It shall be supplied from a vendor listed on the WSDOT Qualified Products List (QPL).

D. **Mulch:** Hydroseed mulch (WSDOT 9-14.5(2)) shall be a fibrous, wood cellulose product produced for this purpose. It shall contain no growth or germination inhibiting substances and shall be manufactured so that when thoroughly mixed with seed, fertilizer, and water, in the proportions indicated it will form a homogenous slurry which is capable of being sprayed. The mulch shall be **Silva Fiber** as manufactured by **Weyerhaeuser Company; Conwood Fiber** as manufactured by **Consolidated Wood Conversion Corp.;** or equal.

E. **Mulch:** Mechanically or hand-spread mulch (WSDOT 9-14.5(2)) shall be a fibrous, wood cellulose product produced for this purpose. It shall be spread to a coverage such that greater than 90% of the soil surface is not visible.

PART 3 -- EXECUTION

3.1 GENERAL

A. **Weather Conditions:** Fertilizing, seeding, or mulching operations will not be permitted when wind velocities exceed 15 miles per hour or when the ground is frozen, unduly wet, or otherwise not in a tillable condition.

B. **Soil Preparation:** The ground to be seeded shall be graded in conformance with the Drawings and shall be loose and reasonably free of large rocks, roots, and other material which will interfere with the work.

C. **Method of Application:** Fertilizer, seed, and mulch may be applied separately (Dry Method), or they may be mixed together with water and the homogeneous slurry applied by spraying (Hydraulic Method), except that all slopes steeper than 3 units horizontal to 1 unit vertical (3:1, H:V) shall be stabilized by the Hydraulic Method.

3.2 DRY METHOD

A. **Fertilizing:** The fertilizer shall be spread uniformly at the rate of 800 lbs per acre (approximately 1 lb per 55 square feet). The fertilizer shall be raked in and thoroughly mixed with the soil to a depth of approximately 2-inches prior to the application of seed or mulch.

B. **Compost Application:** The compost shall be spread uniformly and rolled or tracked down to a depth of 4-inches prior to seeding or hydroseeding.

C. **Seeding:** The seed shall be broadcast uniformly at the rate of 60 lbs/acre (approximately 1 lb per 730 sq ft). After the seed has been distributed it shall be incorporated into the soil by raking or by other approved methods. Seeding shall not be performed from June 1 through September 30, unless the Contractor installs an irrigation system or sprays the seed with water three times per week through this dry season of the year.

D. **Mulch Application:** Mulch shall be applied at the rate of 1,500 lb (air dried weight) per acre (approximately 1 lb per 30 sq ft).

3.3 HYDRAULIC METHOD

A. The hydraulic method consists of the uniform application by spraying of a homogeneous mixture of water, seed, fertilizer, and mulch. The slurry shall be prepared by mixing the ingredients in the same proportions as indicated above. The slurry shall have the proper consistency to adhere to the earth slopes without lumping or running. Mixing time of materials shall not exceed 45 minutes from the time the seeds come into contact with the water in the mixer to the complete discharge of the slurry onto the slopes, otherwise the batch shall be recharged with seed. The mixture shall be applied using equipment containing a tank having a built-in, continuous agitation and recirculation system, and a discharge system which will allow application of the slurry to the slopes at a continuous and uniform rate. The application rates of the ingredients shall be the same as those specified for the Dry Method. The nozzle shall produce a spray that does not concentrate the slurry nor erode the soil.

3.4 WATERING

A. Upon completion of the erosion control seeding, the entire area shall be soaked to saturation by a fine spray. The new planting shall be kept watered by a sprinkling system on the Site during dry weather or whenever necessary for proper establishment of the planting until final project acceptance. At no time shall the planting be allowed to dry out. Care shall be taken to avoid excessive washing or puddling on the surface and any such damage caused thereby shall be repaired by the CONTRACTOR.

3.5 MAINTENANCE PRIOR TO FINAL ACCEPTANCE

A. The CONTRACTOR shall maintain the planted areas in a satisfactory condition until final acceptance of the project. Such maintenance shall include the filling, leveling, and repairing of any washed or eroded areas, as may be necessary and sufficient watering to maintain the plant materials in a healthy condition. The ENGINEER may require replanting of any areas in which the establishment of the vegetative ground cover does not appear to be developing satisfactorily.

3.6 MAINTENANCE AFTER FINAL ACCEPTANCE

A. The CONTRACTOR shall water the permanently planted areas sufficiently to maintain the plant materials in a healthy condition during the 1-year correction period.

END OF SECTION

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SECTION 32 11 13 - A.C. PAVEMENT AND BASE

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The Contractor shall provide A.C. pavement and base, complete and in place, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

AASHTO M 82	Cut-Back Asphalt (Medium Curing Type)
AASHTO M 140	Emulsified Asphalt
AASHTO M 208	Cationic Emulsified Asphalt
AASHTO M 226	Viscosity Graded Asphalt Cement
ASTM D 242	Mineral Filler for Bituminous Paving Mixtures
ASTM D 692	Coarse Aggregate for Bituminous Paving Mixtures
ASTM D 977	Emulsified Asphalt
ASTM D 1073	Fine Aggregate for Bituminous Paving Mixtures
ASTM D 1188	Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens
ASTM D 1557	Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf per cu ft)
ASTM D 2027	Cutback Asphalt (Medium Curing Type)
ASTM D 2397	Cationic Emulsified Asphalt
ASTM D 2726	Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures.
ASTM D 3381	Viscosity-Graded Asphalt Cement for Use in Pavement Construction
ASTM D 3515	Hot-Mixed, Hot-Laid Bituminous Paving Mixtures

1.3 CONTRACTOR SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 - Contractor Submittals. Include materials testing reports, job-mix formulas, and other pertinent information satisfactory to the Engineer.

B. Suitability Tests of Proposed Materials: Tests for conformance with the Specifications shall be performed prior to start of the Work. The samples shall be identified to show the name of the material, aggregate source, name of the supplier, contract number, and the segment of the Work where the material represented by the sample is to be used. Results of all tests shall be submitted to the Engineer for approval. Materials to be tested shall include aggregate base, coarse and fine aggregate for paving mixtures, mineral filler, and asphalt cement.

C. Trial Batch: Before placing any paving material, a testing laboratory acceptable to the Engineer shall prepare a trial batch of asphalt concrete for each job-mix formula to be used by the Contractor for the work. The trial batch shall be prepared using the aggregates and asphalt cement proposed by the Contractor, and approved by the Engineer. The compacted trial batch shall provide a basis for computing the voids ratio, provide an indication of the optimum asphalt content, and establish a basis for controlling compaction during construction. The cost of not more than 2 laboratory trial batch tests will be paid by the Owner but the Contractor shall be responsible for the materials. Performing and paying for any additional trial batch testing shall be the Contractor's responsibility.

PART 2 -- PRODUCTS

2.1 AGGREGATE BASE

A. Materials for aggregate base shall be Crushed Surfacing Base Course and Crushed Surfacing Top Course material in accordance with Section 31 30 00 - Earthwork.

2.2 ASPHALT CEMENT

A. Asphalt Cement shall be Grade **AR-4000 or AR-8000** complying with the requirements of AASHTO M226 (ASTM D 3381).

2.3 MINERAL AGGREGATE

A. Mineral aggregate shall be crushed stone, crushed slag, crushed gravel, stone or slag screening, sand, mineral filler, or a combination of two or more of these materials. Coarse and fine aggregates shall comply with all the quality requirements, except soundness, of ASTM D 692 and D 1073, respectively. Coarse aggregate failing to comply with abrasion requirements may be used if experience has demonstrated it to be satisfactory.

B. Mineral filler shall comply with ASTM D 242.

C. Combinations of aggregates having a history of polishing shall not be used in surface courses.

2.4 ASPHALT-AGGREGATE MIXTURE

A. Base Course Mixture: The Contractor shall submit for approval a job-mix formula for each mixture. The job-mix formula for the asphalt-aggregate base course mixture shall be within the following limits:

Sieve Size	Total Percent Passing by Weight
2-inch	100
1-1/2 inch	100
1-inch	90-100
3/4-inch	-
1/2-inch	56-80
3/8-inch	-
No. 4	29-59
No. 8	19-45
No. 50	5-17
No. 200	1-7

Asphalt Content 3-9 percent by weight of total mix

B. Base Course Mixture Test Criteria: The asphalt-aggregate surface course mixture shall meet the following test criteria:

Stability (Marshall)	2,224 min
Flow (Marshall Method)	8-20
Air Voids	3-5 percent
Voids in Mineral Aggregate	14 percent

C. Surface Course Mixture: The job-mix formula for the asphalt-aggregate surface course mixture shall be within the following limits:

Sieve Size	Total Percent Passing by Weight
1-inch	100

3/4-inch	90-100
1/2-inch	-
3/8-inch	56-80
No. 4	35-65
No. 8	23-49
No. 50	5-19
No. 200	2-8

Asphalt Content 4-10 percent by weight of total mix

D. Surface Course Mixture Test Criteria: The asphalt-aggregate surface course mixture shall meet the following test criteria:

Stability (Marshall)	2,224 min
Flow (Marshall Method)	8-20
Air Voids	3-5 percent
Voids in Mineral Aggregate	16 percent

E. Asphalt-Aggregate Mixture Tolerances: The following tolerances for the job-mix formula will be allowed per single test:

Passing Sieve	Percent
1/2-inch and larger	plus and minus 8
3/8-inch and No. 4	plus and minus 7
No. 8	plus and minus 6
No. 50	plus and minus 5
No. 200	plus and minus 3

Asphalt Content, percent by weight of total mixture plus and minus 0.5

Results of single extraction and sieve tests shall not be used as the sole basis for acceptance or rejection of the mixture. Any variation from the job-mix formula greater than

the tolerances shown above shall be investigated and the conditions causing the variations corrected.

2.5 Joint Sealants

A. Hot Poured Joint Sealants shall be used between asphalt and cement concrete interfaces and at sawcut asphalt interfaces. See requirements of Joint Sealants, WSDOT Section 9-04.2.

PART 3 -- EXECUTION

3.1 SUBGRADE PREPARATION

A. The subgrade shall be prepared in accordance with Section 31 30 00 - Earthwork as applicable to roadways and embankments. The surface of the subgrade after compaction shall be hard, uniform, smooth and true to grade and cross-section. Subgrade for pavement shall not vary more than 0.02-foot from the indicated grade and cross section. Subgrade for base material shall not vary more than 0.04-foot from the indicated grade and cross section.

3.2 AGGREGATE BASE

A. Aggregate base shall be provided where indicated to the thickness indicated. Imported aggregate bases shall be delivered to the Site as uniform mixtures and each layer shall be spread in one operation. Segregation shall be avoided and the base shall be free of pockets of coarse or fine material. Where the required thickness is 6-inches or less, the base materials may be spread and compacted in one layer. Where the required thickness is more than 6-inches; the base material shall be spread and compacted in two or more layers of approximately equal thickness, and the maximum compacted thickness of any one layer shall not exceed 6-inches. The relative compaction of each layer of aggregate base shall be not less than 95 percent of maximum density when measured in accordance with ASTM D 1557. The compacted surface of the finished aggregate shall be hard, uniform, smooth and at any point shall not vary more than 0.02 foot from the indicated grade or cross-section.

3.3 ASPHALT CONCRETE

A. At the time of delivery to the Site, the temperature of mixture shall not be lower than 260 degrees F or higher than 320 degrees F, the lower limit to be approached in warm weather and the higher in cold weather.

B. Asphalt concrete shall not be placed when the atmospheric temperature is below 40 degrees F or during unsuitable weather.

C. The asphalt concrete shall be evenly spread upon the subgrade or base to such a depth that, after rolling, it will be of the required cross section and grade of the course being constructed.

D. The depositing, distributing, and spreading of the asphalt concrete shall be accomplished in a single, continuous operation by means of a self-propelled mechanical spreading and finishing machine designed specially for that purpose. The machine shall be equipped with a screed or strike-off assembly capable of being accurately regulated and adjusted

to distribute a layer of the material to a definite pre-determined thickness. When paving is of a size or in a location that use of a self-propelled machine is impractical, the Engineer may waive the self-propelled requirement.

E. Spreading, once commenced, shall be continued without interruption.

F. The mix shall be compacted immediately after placing. Initial rolling with a steel-wheeled tandem roller, steel three-wheeled roller, vibratory roller, or a pneumatic-tired roller shall follow the paver as closely as possible. If needed, intermediate rolling with a pneumatic-tired roller shall be done immediately behind the initial rolling. Final rolling shall eliminate marks from previous rolling. In areas too small for the roller, a vibrating plate compactor or a hand tamper shall be used to achieve thorough compaction.

G. Upon completion the pavement shall be true to grade and cross-section. When a 10-ft straightedge is laid on the finished surface parallel to the center of the roadway, the surface shall not vary from the edge of the straightedge more than 1/8-in except at intersections or changes of grade. In the transverse direction, the surface shall not vary from the edge of the straightedge more than 1/4-in.

H. The relative density after compaction shall be 95 percent of the density obtained by using ASTM D 1188 or D 2726. A properly calibrated nuclear asphalt testing device shall be used for determining the field density of compacted asphalt concrete, or slabs or cores may be laboratory tested in accordance with ASTM D 1188.

END OF SECTION

SECTION 32 31 13 – CHAIN LINK FENCING AND GATES

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The Contractor shall provide chain link fencing and gates and appurtenant Work, complete and operable, in accordance with the Contract Documents.

B. Single Manufacturer: Chain link fencing, gates, accessories, fittings, and fastenings shall be products of a single manufacturer.

1.2 CONTRACTOR SUBMITTALS

A. General: Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals.

B. Shop Drawings

1. Manufacturer's technical data, product specifications, standard details, certified product test results, installation instructions and general recommendations.

2. Scale layout of fencing, gates, and accessories. Drawings shall show fence height, post layout, including sizes and sections; post setting and bracing configuration, details of gates and corner construction, barbed wire support arms; and other accessories which may be necessary.

C. Samples: Samples of proposed fence components, at least 12-inches long, to illustrate the selected color and finish.

D. Deficiencies of Fence to Remain in Service: Submit a marked-up drawing that lists fence deficiencies and indicates which locations need the repairs.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Dimensions indicated herein for roll-formed pipe and H-sections are outside dimensions, excluding coatings.

B. Fence fabric height shall be 6-feet and match surrounding fencing, unless otherwise indicated.

C. Fencing materials shall be hot-dip galvanized after fabrication.

D. Fencing shall be topped with 3 lines of barbed wire on single, 45 degree supporting arms, sloped outward.

2.2 STEEL FABRIC

A. Fence fabric shall be No. 9 gauge steel wire, 2-inch mesh, with top selvages knuckled and bottom selvages twisted and barbed.

B. Fabric Finish: Fabric shall be galvanized in conformance with ASTM A 392 - Zinc-Coated Steel Chain Link Fence Fabric, Class II, with not less than 2.0 ounces zinc per square foot of coated surface.

2.3 FRAMING AND ACCESSORIES

A. Steel Framework, General: Unless otherwise indicated, framework components shall be fabricated of galvanized steel conforming to ASTM A 53 - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless, or ASTM A 123 - Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products, with not less than 1.8 ounces zinc per square feet of coated surface.

1. Fittings and accessories shall be galvanized in accordance with ASTM A 153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware, with zinc weights per Table I of that standard, except that no coating shall be less than 1.8-ounce zinc per square foot of coated surface.

B. End, Corner and Pull Posts: Posts shall be one-piece without circumferential welds, 3-inch schedule 40 pipe, 5.79 pounds per linear foot.

C. Line Posts: Line posts shall be spaced no more than 10-feet on center and shall be 2-1/4 inch “H” column section, 4.1-pounds per linear foot, or schedule 40, 2-1/2 inch pipe, 3.65-pounds per linear foot.

D. Gate Posts: Gate posts shall be 4-inch schedule 40 pipe, 9.1-pounds per linear foot.

E. Top Rail: Top railing shall be provided in manufacturer’s longest lengths, with expansion type couplings, approximately 6-inches long, for each joint. Fence design shall provide positive, secure attachment of top rail to each gate post, corner post, pull post and end post. Top rail and braces shall be 1-5/8 inch schedule 40 pipe, 2.27-pounds per linear foot, or 1-1/2 inch “H” column section, 2.00-pounds per linear foot.

F. Tension Wire: Tension wire shall be located at the bottom of the fabric and shall consist of No. 7 gauge coated coil spring wire of metal and finish to match fabric. Tension wire shall be interlaced with the fabric or attached to the fabric along the extreme bottom of the fence. Tension wire attachment shall be with fabric tie wires at a spacing of no more than 24-inches apart.

G. Fabric Tie Wires: Fabric tie wires shall be No. 9 gauge galvanized steel wire of the same finish as the fabric. Aluminum ties shall not be used. Ties shall be spaced 14-inches apart on posts and 24-inches apart on rails.

H. Post Brace Assembly: Post brace assembly shall be manufacturer’s standard adjustable brace assembly provided at each end post, gate post and at both sides of each corner post and intermediate brace post. Material used for brace shall be same as top rail. Truss bracing between line posts shall be achieved with 0.375-inch diameter rod and adjustable tensioner.

I. Post Tops: Post tops shall be weather-tight closure caps, designed for containment of top rail and positive permanent attachment to post. One cap shall be provided for each post.

J. Stretcher Bars: Stretcher bars shall be one-piece lengths equal to the full height of the fabric, with minimum cross-section of 3/16-inch by 3-1/2 inch. One stretcher bar shall be provided for each gate and end post, and 2 for each corner and intermediate brace post.

K. Stretcher Bar Bands: Stretcher bar bands shall be one-piece fabrications designed to secure stretcher bars to end, corner, intermediate brace, and gate posts. Bands shall have a minimum cross-section of 1/8-inch by 3/4-inch. Stretcher bar bands shall be spaced no more than 15-inches on center.

L. Barbed Wire Supporting Arms: Supporting arms shall be manufacturer's standard fabrication, of metal and finish to match fence framework, with provision for anchorage to each post and attachment of three rows of barbed wire to each arm. Supporting arms may be either attached to posts or integral with post top weather cap. Supporting arm shall be single 45-degree arm type and shall be capable of withstanding 250 pounds of downward pull at outermost end.

M. Barbed Wire: Barbed wire shall be 2-strand, No. 12-1/2 gauge zinc-coated steel or iron wire with four-point, 14-gauge barbs spaced no more than 5-inches apart.

2.4 GATES

A. Fabrication: Perimeter frames of gates shall be fabricated from same metal and finish as fence framework. Gate frames shall be assembled by welding or with fittings and rivets for rigid, secure connections. Welds shall be ground smooth. Gate frames and any ungalvanized hardware, shall be hot-dip galvanized after fabrication. Horizontal and vertical members shall be provided to ensure proper gate operation and attachment of fabric, hardware and shall be hot-dip galvanized after fabrication.

1. Fabric for gates shall match fence fabric, unless otherwise indicated. Fabric shall be installed with stretcher bars at all perimeter edges. Stretcher bars shall be attached to gate frame with stretcher bar bands spaced no more than 15-inches on center.

2. Each gate shall be diagonally cross-braced with a 3/8-inch diameter adjustable length truss rod to ensure frame rigidity without sag or twist.

3. Where barbed wire is indicated above gates, vertical members shall be extended and fabricated as required to receive barbed wire supporting arms.

B. Swing Gates: Perimeter frames of swing gates shall be constructed of the same pipe or "H" column members as the top rails and shall be fabricated by welding. Welds shall be ground smooth prior to hot-dip galvanizing.

1. Hardware and accessories shall be provided for each gate, galvanized in conformance with ASTM A 153, and in accordance with the following:

a. Hinges: Hinges shall be of size and material to suit gate size, non-lift-off type, offset to permit 180-degree gate opening. Two hinges shall be provided for each leaf less than 6 feet in height.

b. Latch: Latch shall be forked type or plunger-bar type, permitting operation from either side of the gate, with padlock eye as an integral part of the latch.

c. Keeper: Keeper shall be provided which automatically engages the gate leaf and holds it in the open position until it is manually released.

d. Double Gates: Gate stops shall be provided for double gates, consisting of mushroom type flush plate with anchors, set in concrete, and designed to engage center drop rod or plunger bar. Locking device and padlock eyes shall be provided as an integral part of the latch, permitting both gate leaves to be locked with a single padlock.

2.5 RELATED ITEMS

A. Concrete: Concrete shall be provided according to Section 03 31 00 - Cast-In-Place Concrete.

B. Nuts, bolts and screws shall be steel, minimum size 3/8-inch diameter, hot-dip galvanized after fabrication.

2.6 MANUFACTURERS

A. Manufacturer's Qualifications: Chain link fencing and gates shall be products of a single manufacturer which has been successfully engaged in the production of such items for a period of at least 5 years.

B. Installer's Qualifications: Installation of the chain link fence shall be by the manufacturer or by a firm accepted and licensed by the manufacturer.

C. Manufacturers, or equal

1. **American Fence Corp.**

2. **Anchor Fence, Inc.**

3. **United States Steel**

PART 3 -- EXECUTION

3.1 INSPECTION

A. Prior to commencing installation, require Installer to inspect all areas and conditions within which Work of this Section will be performed. Dimensions and clearances shall be verified. Final grading shall be completed and all earth, brush, or other obstructions which interfere with the proper alignment and construction of fencing shall be removed.

B. Fencing along the upper extent of the site will be left intact. Identify any sections of this existing fence that require repairs and make repairs after Engineer approval.

3.2 INSTALLATION

A. General: Unless otherwise indicated, all posts shall be set in concrete. Gate and related posts, corner posts, and other critical elements shall be provided with concrete foundations which are designed by an engineer to safely accommodate the loads to which they will be subjected.

B. Excavation: Holes for posts shall be drilled or hand excavated to the diameters and spacings indicated, in firm, undisturbed or compacted soil. Post foundations which are not designed by an engineer shall comply with the following:

1. Holes shall be excavated to a diameter not less than 12-inches or not less than 5 times the largest dimension of the item being anchored, whichever is larger.

2. Depth for holes shall be not less than 40-inches; excavated approximately 4-inches lower than the post bottom, with bottom of posts set not less than 36-inches below finish grade surface.

C. Setting Posts: Line posts shall be spaced at not more than 10-foot intervals, measured from center to center of the posts, parallel to the ground slope. Posts shall be set plumb and shall be centered in holes, 4-inches above the bottom of the excavation, with posts extending not less than 36-inches below finish grade surface.

1. Corner posts shall be installed where changes in the fence lines equal or exceed 15 degrees, measured horizontally.

2. Each post shall be properly aligned vertically and its top aligned parallel to the ground slope. Posts shall be maintained in proper position during placement and finishing operations.

D. Concrete

1. Concrete for footings may be placed without forms, providing the ground is firm enough to permit excavation to neat line dimensions. Prior to placing concrete, the earth around the hole shall be thoroughly moistened.

2. Encasement concrete for footings shall be placed immediately after mixing in a manner such that there will be no concentration of the large aggregates. The concrete shall be consolidated by tamping or vibrating.

3. Concrete footings shall have a neat appearance and shall be extended 2-inches above grade and troweled to a crown to shed water.

4. A minimum of 7 days shall elapse after placing the concrete footings before the fence fabric or barbed wire is fastened to the posts.

E. Bracing: Bracing shall be provided at all ends, corners, gates, and intermediate brace posts. Corner posts and intermediate brace posts shall be braced in both directions. Horizontal brace rails shall be set midway between the top rail and the ground, running from the corner, end, intermediate brace or gate post to the first line post. Diagonal tension members shall connect tautly between posts below horizontal braces.

1. Braces shall be so installed that posts remain plumb when diagonal rod is under proper tension.

F. Intermediate Brace Posts: Where straight runs of fencing exceed 500-feet, intermediate brace posts shall be installed, spaced equally between ends or corners; with additional posts provided as required, such that the spacing between intermediate brace posts does not exceed 500-feet. Intermediate brace posts shall be equivalent in size to corner posts

and shall be braced with horizontal brace rails and diagonal tension members in both directions.

G. Top Rails: Top rails shall be run continuously through post caps, bending to radius for curved runs. Expansion couplings shall be provided as recommended by the fencing manufacturer.

H. Tension Wire: Continuous bottom tension wire shall be stretched tight with turnbuckles at end, gate, intermediate, and corner posts. Tension wire shall be installed on a straight grade between posts, with approximately 2-inches of space between finish grade and bottom selvage, unless otherwise indicated. Tension wire shall be tied to each post with not less than 6 gauge galvanized wire.

I. Fabric

1. Chain-link fabric shall be fastened on the secured side of the posts.

2. Fabric shall be stretched and securely fastened to posts. Between posts, top and bottom edges of the fabric shall be fastened to the top rail and bottom tension wire, respectively.

3. Fabric shall be stretched and anchored in such a manner that it remains in tension after the pulling force is released.

J. Tie Wires: Tie wire shall be bent to conform to the diameter of the pipe to which it is attached, clasping pipe and fabric firmly with ends twisted at least two full turns. Ends of wire shall be bent back to minimize hazard to persons or clothing.

1. Fabric shall be tied to line posts with tie wires spaced at 12-inches on center.

2. Fabric shall be tied to rails and braces with tie wires spaced at 24-inches on center.

3. Fabric shall be tied to tension wires, with hog rings spaced 24-inches on center.

K. Stretcher Bars: Fabric shall be fastened to end, corner, intermediate brace, and gate posts with stretcher bars. Bars shall be threaded through or clamped to fabric at 4-inches on center and secured to posts with stretcher bar bands spaced no more than 14-inches on center.

L. Fasteners: Nuts for tension bands and hardware bolts shall be installed on the side of fence opposite the fabric side. Ends of bolts shall be peened or the threads scored to prevent removal of nuts.

M. Galvanized coating damaged during construction of the fencing shall be repaired by application of Galvo-Weld; Galvinox; or equal.

END OF SECTION

SECTION 32 93 00 - LANDSCAPING

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide landscaping and appurtenant work, complete and in place, in accordance with the Contract Documents.

B. The CONTRACTOR shall design and provide a permanent automatic irrigation system for all new planting areas shown on the Contract Documents.

1.2 DEFINITIONS

A. The terms "plant material" or "plants" refer to all vegetation, whether trees, shrubs, ground cover, or herbaceous vegetation.

B. "Quality" refers to structure and form, as evidenced by density and number of canes and branches, compactness, symmetry, and general development without consideration of size or condition. "Standard quality" indicates the least acceptable quality. "Standard quality" plants shall be typical of the species and variety of good average uniform growth, shall be well formed and uniformly branched, and shall have the minimum number of canes indicated, free from irregularities, or shall conform to minimum quality index. Where the number of canes is not specifically stated in describing this grade, the "Horticultural Standards" as adopted by the American Association of Nurserymen shall apply. In such a case, the number of canes and other factors for the appropriate classification under "quality definition" in the Horticultural Standards shall be the Quality Index. Plant material below this standard will be considered "culls" and are not acceptable. Plants shall be nursery grown.

C. "Specimen" means an exceptionally heavy, symmetrical, tightly-knit plant, so trained or favored in its development and appearance as to be outstanding, superior in form, number of branches, compactness, and symmetry.

D. "Size" is the factor controlled by dimensions representing height or spread, or both, without consideration of quality or conditions. For standard quality, a dimension is given for height or container size, or a dimension is given for height as well as container size.

E. "Height" is usually indicated with a tolerance. The smaller dimension is the minimum acceptable. The larger dimension represents the maximum permissible. The average dimension of all plants shall equal the average of the tolerance figures for each item.

F. "Condition" is the factor controlled by vitality and ability to survive and thrive and be comparable with normal plants of the same species and variety in the vicinity at the same season of the year. Plants shall be free from physical damage or adverse conditions that would prevent thriving. "Condition" also sometimes refers to state of growth, i.e., whether "dormant condition" or "growing condition" and this state shall be comparable to plants of similar species in the vicinity for leaves, formation of buds, and the like.

G. "Cane" means a primary stem which starts from the ground, or close to the ground, at a point not higher than 1/4 the height of the plant.

H. "Caliper" shall be measured 12 inches above the finish grade or ground, as a guide, or where the trunk appears to form the head of the tree.

I. "Foliage line" is maximum dimension in case of specimen plants. It measures from ground to lowest part of body of plant.

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

ASTM D 422 Method for Particle-Size Analysis of Soils

ANSI Z60.1 American Standard for Nursery Stock, Current Edition

2015 City of Wilsonville Stormwater & Surface Water Design & Construction Standards

2017 City of Wilsonville Public Works Construction Standards

1.4 CONTRACTOR SUBMITTALS

A. **General:** Submittals shall be furnished in accordance with Section 01300 - Contractor Submittals.

B. Product Information

1. Manufacturer's product information on fertilizer, peat moss, mulch, compost, seed mixtures, benches, steel edging, picnic tables and trash receptacles.

2. Permanent Irrigation System: Provide manufacturer’s product information on all irrigation components and materials.

3. **Landscape Planting and Seeding:** Topsoil Analysis Report: A report certified by an analytical laboratory which shows results of analyzing representative samples of topsoil proposed for use. Approval of the report does not constitute final acceptance of the topsoil.

4. **Stormwater Bioswale Growing Media:** A report certified by an analytical laboratory which shows results of analyzing representative samples of topsoil proposed for use. Approval of the report does not constitute final acceptance of the growing media

5. **Compost:** A technical analysis and data report consistent with sampling and reporting requirements of the U.S. Composting Council Seal of Testing Assurance (STA) Program.

C. Certificate

1. Certificates shall accompany each delivery stating source, quantity, and type of material. All certificates shall be submitted at the time of delivery.

2. Certificates of inspection of plant material, as may be required by Federal, State, or other authorities having jurisdiction, which accompany the shipment, shall be submitted at delivery.

3. The CONTRACTOR shall guarantee to perform planting maintenance services during the one year correction of defects period.

4. The CONTRACTOR shall perform planting maintenance for an additional Three-years after the initial one-year correction of defects period.

5. Stormwater Facility Landscape Maintenance Assurance Certificate.

D. Samples

1. Three samples of typical plants from each variety and size indicated shall be submitted. If approved, samples shall be planted and maintained as standards for comparison with plants provided.

2. Samples of grass seed: 1-lb samples of each type of grass seed required with the dealer's guaranteed germination rate. Grass seed shall not be delivered to the Site prior to written approval of the samples. Approval of the samples, however, shall not affect the right of the ENGINEER to reject the seed upon or after delivery.

3. Samples of Stormwater Facility Growing Medium: 1-lb sample of blended growing medium

4. Samples of Compost: 1-lb sample of Compost.

1.5 QUALITY ASSURANCE

A. **General:** All plants shall be true to type or name as indicated in the Contract Documents and shall be tagged in accordance with the standard practice however, determination of plant species or variety will be made by the ENGINEER.

B. All plants shall comply with Federal and State laws requiring inspection for plant diseases and infestations.

C. The CONTRACTOR shall obtain clearance from the County Agricultural Commissioner, as required by law, before planting plants delivered from outside the County in which they are to be planted. Evidence that such clearance has been obtained shall be filed with the ENGINEER.]

D. Inspections will be made by the ENGINEER or its representative. The CONTRACTOR shall request inspection at least 24 hours in advance of the time inspection is required. Inspection is required on the following stages of the WORK:

1. During preliminary grading, soil preparation, and initial weeding.

2. When trees are spotted for planting, but before planting holes have been excavated.

3. When finish grading has been completed.

4. When all WORK except the maintenance period has been completed.

5. Final inspection at the completion of the maintenance period.

E. Plants shall be subject to inspection and approval or rejection by the ENGINEER at place of growth and upon delivery to the Site at any time before or during progress of the WORK based on:

1. Quantity, quality, size, and variety;

2. Ball and root condition; and

3. Latent defects and injuries resulting from handling, disease, and insects.

F. Plants approved at pre-planting inspection are subject to rejection during planting if found to be defective.

G. Rejected plants shall be identified as such in an obvious manner, shall be removed from the Site, and be replaced with acceptable plants.

H. Plants shall have been grown in nurseries that have been inspected by the governing authorities. Inspection of plant materials required by City, County, State, or Federal authorities shall be the responsibility of the CONTRACTOR, who shall have secured permits or certificates prior to delivery of plants to Site.

1.6 CLEANUP

A. Upon completion of all planting operations, the portion of the Site used for a work or storage area by the CONTRACTOR shall be cleaned of all debris, superfluous materials, and equipment. All such materials and equipment shall be entirely removed from the Site in accordance with Section 01700 - Project Closeout.

B. All walks or pavement shall be swept or washed clean upon completion of the WORK of this Section.

C. During the entire Contract period, plant containers that have been cut or removed from plant materials shall be removed from the Site daily.

1.7 MAINTENANCE OF LANDSCAPING PLANTING PRIOR TO ACCEPTANCE OF PROJECT

A. **General:** The CONTRACTOR shall be responsible for protecting, watering, and maintaining all planting and irrigation systems until final acceptance of all WORK under the Contract.

B. **Stormwater Management Facilities**

1. The CONTRACTOR shall be responsible for maintaining the Stormwater Bioswale meeting the requirements of the Contract Documents.

C. At time of acceptance of the complete project, the lawn shall be totally established with no bare spots, have been mowed a minimum of 3 times, and the grass shall be at least 1-1/4 to 2 inches in height.

D. **Watering:** Trees and shrubs shall be thoroughly soaked after planting and provided with additional water at intervals as necessary to provide for good health and growth of the planting.

E. Upon completion of lawn seeding, the entire area shall be soaked to saturation by a fine spray. The new plantings (Trees, Shrubs, Ground Cover and Bioswale Plantings) shall be kept watered by a Contractor designed automated temporary sprinkling system during dry weather or whenever necessary for proper establishment of the lawn. Care shall be taken to avoid excessive washing or puddling on the surface and any such damage caused thereby shall be repaired.

F. **Protection:** The CONTRACTOR shall provide adequate protection to all newly seeded areas including the installation of approved temporary fences to prevent trespassing and damage, as well as erosion control, until the end of the correction of defects period.

G. The CONTRACTOR shall replace any materials or equipment or which its employees or Subcontractors have damaged.

H. Partial utilization of the project shall not relieve the CONTRACTOR of any of the requirements contained in the Contract Documents.

I. **Mowing of Lawn Areas:** First mowing of lawn areas shall begin as soon as the grass has reached a height of 3 inches and subsequent mowing shall be at least once a week, or as often as necessary to maintain all lawn areas at a uniform height of 1-1/2 to 2 inches.

J. All lawns shall be fertilized every 3 weeks with 6 lb of 16-16-8 commercial fertilizer per 1000 sq ft for the first 7 weeks and be fertilized thereafter once each 5 months prior to acceptance.

K. Plants shall be maintained in a vigorous, thriving condition by watering, cultivating, weeding, pruning, spraying, and other operations necessary. No trees or shrubs will be accepted unless they are healthy and show satisfactory foliage conditions.

L. All planted areas shall be cultivated at least every 2 weeks and be raked smooth to present a neat appearance, and additional mulch shall be added where necessary.

M. Maintenance shall include, in addition to the foregoing, cleaning, edging, repairs to stakes, wire, and wrappings, the repair of erosion, and all other necessary work of maintenance. Sidewalks and other paved areas shall be kept clean while planting and maintenance are in progress.

N. Any existing sprinkler lines broken or disrupted shall be replaced to proper working order prior to work under this Contract and shall be acceptable to the OWNER.

1.8 FINAL INSPECTION AND GUARANTEE

A. Inspection of lawns and planting will be part of final inspection under the Contract.

B. Written notice requesting inspection shall be submitted to the ENGINEER at least 10 days prior to the anticipated inspection date.

C. Final acceptance prior to start of the guarantee period of the Contract will be on written approval by the ENGINEER, on the satisfactory completion of all WORK, including maintenance, but exclusive of the replacement of plant material.

D. Any delay in the completion of any item of work in the planting operation which extends the planting into more than one season shall extend the correction period in accordance with the date of completion given above.

E. The CONTRACTOR shall replace, as soon as weather conditions permit, all dead plants and all plants not in a vigorous, thriving condition which are noted at the end of the one-year correction period and annually during the Maintenance and Guarantee period.

F. Plants used for replacement shall be of the same size and variety on the Plant List. Replacement plants shall be furnished, planted, staked, and mulched as indicated for new plants.

G. All WORK under this Section shall be left in good order to the satisfaction of the OWNER and the ENGINEER, and the CONTRACTOR shall, without additional expense to the OWNER, replace any trees, shrubs, etc., which develop defects or die during the one-year correction period.

1.9 MAINTENANCE AND GUARANTEE FOLLOWING ACCEPTANCE OF PROJECT.

A. **General:** The CONTRACTOR shall be responsible for a period of three years after date of acceptance of the WORK of this Section, for maintaining all plantings, including all necessary plant or tree replacements, weeding, cultivating, fertilizing, pruning, controlling insects and diseases, re-guying, and performing all other operations incident thereto, as well as maintenance of the irrigation system in Section 33 83 00- Landscape Irrigation System. The CONTRACTOR shall obtain a written guarantee from the landscaping Subcontractor embodying the provisions of this paragraph.

B. **Stormwater Facility Bioswale:** The CONTRACTOR shall be responsible for a period of three years after date of acceptance of the WORK of this Section, for maintaining all plantings, including all necessary plant or tree replacements, weeding, cultivating, fertilizing, pruning, controlling insects and diseases, re-guying, and performing all other operations incident thereto as well as maintenance of the temporary irrigation system meeting the requirements of the Contract Documents

C. The WORK covered by the maintenance and guarantee portions of this paragraph includes providing all replacements of plants, labor, materials, equipment, and supplies and in performing all operations in connection with maintenance and guarantees.

D. The inspection of lawn areas is independent of the final inspection and maintenance period. After the lawn has been accepted and has been mowed 4 or more times, the responsibility for mowing and irrigation system will be the responsibility of the CONTRACTOR for the duration of the MAINTENANCE AND GUARANTEE period described in this section.

E. Weeding, fertilizing, and controlling of diseases of the lawn areas shall be the responsibility of the CONTRACTOR for the duration of the MAINTENANCE AND GUARANTEE period .

F. All plant materials shall be in a condition acceptable to the OWNER or its representative at the end of the maintenance guarantee period.

G. The OWNER will furnish all water required during the maintenance and correction period.

H. **Maintenance:** Watering and mowing of the lawn during the maintenance and correction period will be performed by the CONTRACTOR in accordance with written instructions which shall be furnished by the CONTRACTOR.

I. The CONTRACTOR shall make any changes or adjustments necessary to the temporary irrigation system during the maintenance and correction period.

J. The CONTRACTOR shall replace any dead or diseased plants during the maintenance and correction period.

K. All lawn and planting areas shall be fertilized during the maintenance and correction period with 16-6-4 chemical fertilizer. Amount of fertilizer applied shall be per fertilizer's written instructions on bag. Fertilizers applied to planting areas shall be cultivated into the top 2 inches of topsoil.

L. The CONTRACTOR shall clean-up and remove unused or waste materials from the Site and leave the area in a neat condition satisfactory to the OWNER whenever it performs work during the maintenance period.

M. **Final Inspection:** The OWNER and CONTRACTOR shall make a final inspection at the end of the MAINTENANCE AND GUARANTEE period . Any plants and materials found defective at time of final inspection shall be replaced within a time agreed upon by both parties. If it is too late in the planting season for replanting, the replacements shall be made during the next planting season even though such planting may run beyond the maintenance and correction period.

PART 2 -- PRODUCTS

2.1 GENERAL

A. All landscaping materials for soil conditioning, weed abatement, or planting shall be first-grade, commercial quality and shall have certificates indicating the source of material, analysis, quantity, or weight attached to each sack or container or furnished with each delivery. Delivery certificates shall be given to the ENGINEER as each shipment of material is delivered. A list of the materials used, together with typical certificates of each material, shall be submitted to the ENGINEER prior to final acceptance.

2.2 TOPSOIL FOR RESTORATION SEEDING

A. Topsoil shall be obtained from naturally drained areas and shall be fertile, friable loam suitable for plant growth. Topsoil may be salvaged from the site or imported and shall be subject to inspection and approval at the source of supply and upon delivery.

B. The topsoil shall be of uniform quality, free from subsoil, stiff or lumpy clay, hard clods, hardpan, rocks, disintegrated debris, plants, roots, seeds, and any other materials that would be toxic or harmful to plant growth. Topsoil shall contain no noxious weeds or noxious weed seeds.

C. Imported topsoil shall contain at least 6 percent organic matter as determined by loss of weight after ignition of moisture-free samples in accordance with current methods of the Association of Official Agricultural Chemists.

D. The acidity of the topsoil shall result in soil pH between 5.5 and 7.5. The salinity level shall be less than 3 millimhos/cm.

E. Clay, as determined by the Bouyoucous hydrometer or by the decantation method, shall not exceed 60 percent of the topsoil material.

F. Mechanical analysis shall be performed and shall conform to ASTM D 422.

2.3 STORMWATER FACILITY GROWING MEDIUM

A. Growing Medium for the Stormwter Facility Bioswale shall be the Default Bioretention Soil Mix (BSM) meeting the requirements of the 2024 Washington Department of Ecology Stormwater Management Mannual for Western Washington (SWMMWW). Refer to the 2024 SWMMWW, Volume V Chapter 5 pages 898 to 901.

2.4 FERTILIZER AND ADDITIVES

A. Fertilizer shall be furnished in bags or other standard containers with name, weight, and guaranteed analysis of contents clearly marked thereon.

B. Chemical fertilizers shall be a free-flowing factory-mixed commercial fertilizer with percentages of nitrogen, phosphoric acid, and potash at 5-10-5. Fertilizers shall be uniform in composition, dry, and free flowing.

C. Animal fertilizer shall be well-rotted cattle manure, free from weed seeds, sawdust, shaving, or refuse of any kind, and shall contain not more than 25 percent straw by volume.

D. Tablets shall be 12 grams each 20-10-5 **"Agriform," "Lesslie"**, or equal.

E. Lime shall be dolomite limestone containing not less than 85 percent of total carbonates. Limestone shall be ground to such fineness that 100 percent will pass a No. 200 sieve.

F. Agricultural gypsum shall be standard brand agricultural calcium sulfate intended for soil application and shall contain 19 percent combined sulfur.

2.5 MULCH

A. "Silva-fiber" mulch material as the mulch component in hydroseeding mixtures shall be "Silva-fiber" as manufactured by the **Weyerhauser Company, Silva Products Department**, Tacoma, Washington, or equal.

B. Wood chip mulch for top dressing in planting beds shall be clean, inexpensive, pulverized shavings, 2-inch minimum to 4-inch maximum length as produced by chipping tree branches or similar means, placed to a depth of 4-inches.

C. Straw mulch or native hay for a soil/seed stabilizer shall be clean hay or straw applied at a rate of 3 tons per acre. Mulch is to be crimped into soil with a mulch crimper. Spacing on the blades of the mulch crimper shall be 6-inches minimum and 9 inches maximum. Blades shall be sufficiently weighted to penetrate the ground 3-inches.

2.6 COMPOST

A. Compost shall be derived from green material consisting of chipped, shredded, or ground vegetation or clean, processed, recycled wood products or a Class A, exceptional quality biosolids composts, as required by the United States Environmental Protection Agency (EPA), 40 CFR, Part 503c regulations or a combination of green material and biosolids compost. The compost shall be processed or completed to reduce weed seeds, pathogens, and deleterious material, and shall not contain paint, petroleum products, herbicides, fungicides, or other chemical residues that would be harmful to plant or animal life. Other deleterious material, plastic, glass, metal, or rocks shall not exceed 0.1 percent by weight or volume.

B. Additional Requirements

The carbon to nitrogen ratio of the compost shall be below 20:1.

The compost shall have an organic matter content of 35% to 65% as determined by "loss on ignition" test method.

C. Compost shall be supplied by a certified U.S. Composting Council STA program approved facility. https://www.compostingcouncil.org/page/participants#OR

D. Submit one-gallon sample, source, and letter of certification from the supplier to the ENGINEER for approval prior to installation.

2.7 PLANT MATERIALS

A. Plants shall meet requirements of the Contract Documents and shall be in accordance with the botanical names and applicable standards of quality, size, condition, and type. Plants shall be true to name, genera, species, and variety in accordance with reference publications.

B. Plant names are defined in "Standardized Plant Names" and "Bailey's Encyclopedia of Horticulture." When a name is not found in either reference, the accepted name used in the nursery trade shall apply.

C. Plants shall be marked for identification. Each bundle of plants and at least 25 percent of each species and variety of separate plants in any one shipment shall have legible labels securely attached before delivery to the Site.

D. Trees and shrubs shall be measured while their branches are in their normal position. Height and spread dimensions refer to the main body of the plant and not from branch or root tip to tip. No trees will be accepted with leaders cut or so damaged that cutting is necessary.

E. All plants shall be symmetrical and shall conform to the size, age, and condition on the Plant List. Exceptions are as follows:

1. Plants larger than indicated on the plant list may be used if approved by the ENGINEER, but approval of such plants shall not increase the Contract Price. If the use of larger plants is approved, the spread of roots or ball earth shall be increased in proportion to the size of the plant. Bare root plants furnished in size greater than indicated shall be balled and burlapped when required by the ENGINEER.

2. Where caliper or other dimensions of any plant materials are omitted from the Plant List, it shall be understood that such plant materials shall be normal stock for type listed.

F. Plants shall be of sound health, vigorous, and free from plant disease and shall be well branched, shall have full foliage when in leaf, and shall have a healthy well-developed normal root system. Cold storage plants will not be accepted. Plants that are sensitive to shock from elevation change shall be grown for at least 2 years at elevations close enough to the Site to alleviate any plant damage due to such change.

G. Bare rooted (BR) plants shall have well-developed branch systems and vigorous root systems. They shall be dug to sufficient depth to insure full recovery and development of the plants. Roots of these plants shall be covered with a uniformly thick coating of mud puddled immediately after they are dug.

H. Balled and burlapped (BB) plants shall have firm, natural balls of earth of diameter not less than that indicated and be of sufficient depth to include all the fibrous and feeding roots. No plant moved with a ball will be accepted if the ball is cracked or broken before or during plant operations, except on approval of the ENGINEER.

I. Roots or balls of all plants shall be adequately protected at all times from sun and drying winds.

J. Plants indicated to be in marked cans, pots, or other containers on the Plant List shall have been grown in the containers for a minimum of 6 months and a maximum of 2 years. Roots shall fill the containers but show no evidence of being or having been root bound.

K. Trees shall have straight trunks and all old abrasions and cuts shall be completely callused over. In no case shall trees be topped before delivery.

L. Plants shall have been transplanted or root-pruned at least once in the 2 years prior to delivery, but plants shall not be pruned immediately prior to delivery except as authorized by the ENGINEER.

2.8 SEED MIXTURES

A. Seed shall conform to applicable City, County, State, and Federal regulations. Seed shall be mixed by dealer. The CONTRACTOR shall furnish dealer's guaranteed germination figure for each variety. Grass seed shall not be delivered until samples have been approved in writing by the ENGINEER or its authorized landscape representative. Approval of samples, however, shall not affect the right of the ENGINEER or the authorized landscape representative to reject seed upon or after delivery. Seed that has become wet, moldy, or otherwise damaged prior to use will not be accepted.

B. Grass seed shall be fresh, clean, new-crop seed, composed of the following varieties mixed in the proportions by weight. Purity and germination percentage shall be the results of testing.

Seed Mix A - 'Low Grow' Lawn Seed Mix Application Rate: 8#/1000 sq.ft.

Kind/Variety Seed in Mixture	Percent by Weight	Percent Pure Seed	Minimum Percent Germination
Dwarf tall fescue	45	98 Minimum	90
Dwarf perennial rye (Barclay)	30	98 Minimum	90
Red fescue	20	98 Minimum	90
Colonial bentgrass	5	98 Minimum	90

2.9 STAKING MATERIALS

A. Stakes for supporting trees shall be as shown on planting details.

B. Tree ties of other materials may be used with prior approval of ENGINEER.

2.10 SITE FURNISHINGS

A. BENCHES

1. Shall be Contour Recycled Plastic Bench with Steel Frame – 6 foot, as provided by TheParkCatelog. Color Green. Contact: www.theparkcatalog.com. Tel: 800-695-3503, Or approved equal.

B. TRASH RECEPTACLES

1. Shall be Trashcans Unlimited 40 Gallon Lase Cut Saw Grass Wast Can, with Flat Top Lid, Color Gree, as manufactured by Trash Cans Unlimited, www.trashcansunlimited.com, Tel: 800-279-3615, Or approved equal.

C. PICNIC TABLES

1. Shall be 4'-Square Recycled Plastic T-Table, as provided by TheParkCatalog. Color Green. Contact: www.theparkcatalog.com. Tel: 800-695-3503, Or approved equal.

2.11 MISCELLANEOUS MATERIALS

A. Cobble shall be clean, rounded river cobble, as shown on Plans

B. Landscape Boulders shall be 3-Man Basalt Rock (28"-36" in diameter) dark colored and substantially free from breaks, gouges, and other imperfections. The CONTRACTOR shall obtain approval of rock on site prior to installation. Remove rejected boulders from the Site.

C. METAL EDGING

1. Shall be 4" 12-gauge coated steel landscape edging as manufactured by Coyote Landscape Products. Color: Black, Or approved equal.

D. Erosion Control Matting

1. Organic temporary erosion control blanket shall meet the following requirements:

2. Made of natural plant fibers.

3. Have a minimum weight of 8 oz./sq. yd. and a minimum limiting shear stress of 0.45 lb./sq. ft.

E.

PART 3 -- EXECUTION

3.1 GENERAL

A. The Stormwater Management Facility Bioswale shall be planted and functional prior to impervious surfaces being installed.

B. The landscape work shall not be performed at any time when it may be subject to damage by climatic conditions.

C. The CONTRACTOR shall carefully scale or otherwise verify all dimensions in the Contract Documents. Dimensions and plant locations shall be coordinated with ENGINEER and final location shall be Site-oriented by the planter and ENGINEER. Any discrepancies or inconsistencies shall be brought to the attention of the ENGINEER.

D. In case of conflict between the Plant List totals and total plant count of the Contract Documents, the CONTRACTOR shall provide the higher number of plants.

E. Delivery of materials may begin only after samples and tests have been approved by the ENGINEER. Materials provided shall be not less quality than the approved sample.

F. Substitutions for the indicated plant materials may be considered pursuant to the Contract Documents.

G. The CONTRACTOR shall provide temporary fencing, barricades, covering, or other protections to preserve existing landscaping items indicated to remain and to protect the adjacent properties and other structures when they may be damaged by the landscape work.

H. The CONTRACTOR shall retain the services of a tree surgeon approved by the ENGINEER to repair damage to existing trees. Existing trees which are to be saved and which cannot be restored to full growth, as determined by tree surgeon, shall be removed and replaced with a new similar tree of 24-inch box size unless otherwise approved by the ENGINEER.

I. The CONTRACTOR shall remove and/or relocate landscape items such as trees, shrubs, grass, other vegetation, improvements, and obstructions as indicated.

J. Waste materials shall be removed and disposed of off the Site, unless otherwise indicated.

K. It shall be the responsibility of the CONTRACTOR to obtain information regarding utilities in the area of work and to prevent damage to the same. The CONTRACTOR shall protect the utilities as necessary.

L. Burning of combustible materials on the Site shall not be permitted.

M. The CONTRACTOR shall protect structures, sidewalks, pavements, and other facilities that are subject to damage during landscape work. Open excavations shall be provided

with barricades and warning lights which conform to the requirements of governing authorities and the State's OSHA safety requirements from dusk to dawn each day and when needed for safety.

N. Planting areas include all areas to be landscaped unless indicated otherwise.

3.2 SOIL PREPARATION

A. The landscape work shall not begin until all other trades have repaired all areas of settlement, erosion, rutting, etc., and the soils have been re-established, recompacted, and refinished to finish grades. The ENGINEER shall be notified of all areas that prevent the landscape work from being executed.

B. Areas requiring grading by the landscaper including adjacent transition areas shall be uniformly level or sloping between finish elevations to within 0.10-ft above or below required finish elevations.

C. The landscape work shall not proceed until after walks, curbs, pavings, edging, and irrigation systems are in place. WORK under the Contract shall be completed to a point where the landscape areas will not be disturbed. The subgrade shall be free of waste materials of all kinds.

D. During grading, waste materials in the planting areas such as weeds, rocks 2-inches and larger, building materials, rubble, wires, cans, glass, lumber, sticks, etc., shall be removed from the Site. Weeds shall be dug out by the roots.

E. Fertilizers, additives, seed, peat, etc. subject to moisture damage shall be kept dry in a weatherproof storage place.

F. After removal of waste materials, the planting area subgrade shall be scarified and pulverized to a depth of not less than 6-inches, and all surface irregularities below the cover of topsoil shall be removed.

G. Finish grading shall consist of:

1) Final contouring of the planting areas.

2) Placing half the depth of specified topsoil.

3) Placing all soil additives and fertilizers.

4) Tilling of planting areas to a depth of 6-inches.

5) After tilling, place second lift of specified topsoil and bring areas to uniform grades by floating and/or hand raking.

6) Making minor adjustment of finish grades as directed by the ENGINEER.

7) Removing waste materials such as stones, roots, or other undesirable foreign material larger than 1” in diameter and raking, disking, dragging, and smoothing soil ready for planting.

H. Any unusual subsoil condition that will require special treatment shall be reported to the ENGINEER.

I. Topsoil shall be uniformly distributed over all areas where required. Subgrade and topsoil shall be damp and free from frost.

J. Surface drainage shall be provided as indicated by shaping the surfaces to facilitate the natural run-off of water. Low spots and pockets shall be filled with topsoil and graded to drain properly.

K. Finish grade of all planting areas shall be 1-1/2 inches below finish grade of adjacent pavement of any kind.

3.3 TOPSOIL AND COMPOST PLACEMENT

A. Topsoil and Compost shall be placed and incorporated into subgrade as indicated in the table below

PLANTING AREA	TOPSOIL DEPTH	COMPOST DEPTH	SOIL PREPARATION REQUIRED PER PARAGRAPH "SOIL PREPARATION"
PLANTING AREAS	12-INCHES	0-INCHES	YES
LAWN AREAS	6-INCHES	0-INCHES	YES
EROSION CONTROL SEEDING AREAS	0-INCHES	4-INCHES	YES
STORMWATER MANAGEMENT FACILITY - BIOSWALE	18-INCHES	4-INCHES	YES

3.4 DELIVERY, STORAGE, AND HANDLING OF PLANT MATERIALS

A. No plants other than the required samples shall be dug or delivered to the Site until the required inspections have been made and the plant samples are approved.

B. Plants shall not be pruned prior to delivery except upon approval by the ENGINEER.

C. Plant material shall be planted on the day of delivery if possible. The CONTRACTOR shall protect the stock in a temporary nursery at the Site where it shall be protected from sun and drying winds and shall be shaded, kept moist, and protected with damp soil, moss, or other acceptable material. Plants shall be planted within 2 days after delivery.

D. All balled and burlapped plants which cannot be planted immediately after delivery shall be set on the ground and be well protected with soil, wet moss, or other acceptable material. Bare rooted plants, which cannot be planted immediately, shall be planted in heeled-in trenches immediately upon delivery. No material heeled-in for more than one

week may be used. Bundles of plants shall be opened and the plants separated before the roots are covered. Care shall be taken to prevent air pockets among the roots.

E. During planting operations, bare roots shall be covered with canvas, wet straw, or other suitable materials. No plants shall be bound with wire or rope at any time so as to damage the bark or break branches.

F. Plants shall not be picked up or moved by stem or branches, but shall be lifted and handled from the sides of the containers.

G. Plants shall be lifted and handled from the bottom of the ball or container. Plants with balls cracked or broken before or during planting operations will not be accepted and shall be immediately removed from the Site.

3.5 TREE AND PLANT LOCATIONS

A. The CONTRACTOR shall locate and stake all tree and shrub locations and have the locations approved by the ENGINEER before starting excavation for same. The plant locations shall be observed, and their locations shall be adjusted as directed by ENGINEER before final approval.

B. No trees shall be located closer than 72-inches to structures unless otherwise indicated. Ground covers and shrubs may be planted up to structures or curbs.

3.6 PLANT PITS

A. Plant pits, centered on location stakes, shall be excavated circular pits with vertical sides and flat or saucer shape bottom in accordance with the following sizes unless indicated otherwise:

1. Tree pits shall be at least 2-feet greater in diameter than the specific diameter of ball or spread of roots, and at least 6-inches below depth of ball or roots. A 3-inch layer of compost shall be worked thoroughly to a depth of 6-inches below the pit bottom.

2. Shrubs shall be planted in pits or holes of soil 24-inches deep below finished grade, or as much deeper as necessary to properly set the plant at finished grade with a minimum of 6 inches of planting soil under balls of all plants. Shrubs with balls shall be planted in pits that are at least 24-inches greater in diameter than the bottom of ball. Bare root shrubs shall be planted in pits at least 12-inches below the roots of the plant.

3.7 PREPARED BACKFILL

A. Tree and shrub pit backfilling soil shall consist of Stormwater Facility Growing Medium. Commercial fertilizer shall be sparingly mixed with the prepared Growing Medium, using 5 lb/cu yd or as required by manufacturer's printed recommendations.

B. Materials shall be thoroughly rotary-mixed on the Site before placement. Mixing of materials in pits, bins, trenches or beds will not be permitted.

C. Tree and shrub pits shall be provided with fertilizer tablets as follows:

1 per one-gallon can plant

3 per 5-gallon can plant

5 per 15-gallon can plant

3.8 ROCKS OR UNDERGROUND OBSTRUCTIONS

A. In the event that rock or underground obstructions are encountered in the excavation of plant pits, alternative locations will be selected by the ENGINEER. Moving of trees to alternative locations shall not entail additional costs to the OWNER.

3.9 SETTING PLANT MATERIALS

A. The soil shall not be worked when the moisture content is so great that excessive compaction will occur, nor when it is so dry that a dust will form in the air or that clods will not break readily. Water shall be applied if necessary to provide ideal moisture for filling and for planting.

B. Plants shall be set plumb and straight in center of pits, and at such a level that after settlement that the crown of the plant will be 2-inches above the finished grade.

C. Balled and burlapped trees shall have planting soil placed and compacted around base of ball to fill all voids. All burlap ropes or wires shall be removed from the sides and tops of balls.

D. Roots of bare root plants shall be properly spread out and planting soil carefully worked in among them. All broken or frayed roots shall be cut off clean.

E. Vines shall be removed from stakes, untied, and securely fastened in an approved manner to wall or fence next to which they are planted.

F. Ground cover plants shall be evenly spaced, staggered in rows, and set at intervals indicated, so as to produce a uniform effect. Plants shall be watered immediately after planting operations have been completed.

G. Shrubs and vines shall be pruned to remove damaged branches. All bare root shrubs shall be pruned and shaped to compensate for transplant root loss.

H. Planting soil around roots or balls shall be thoroughly compacted and watered. After planting, the soil in the shrub beds shall be cultivated between shrubs, raked smooth, and neatly outlined. Muddy soil shall not be used for backfilling. All broken or frayed roots shall be properly cut off.

I. Trees and shrubs on slopes steeper than 6 to 1 shall be provided with watering dams or berms at least 6-inches high and 8-inches wider than planting pit unless indicated otherwise.

J. Trees shall be thoroughly watered immediately after planting.

K. Remove all tags and labels when directed by ENGINEER.

L. Trees shall have trunks wrapped in acceptable tree wrap material from base up to and above at least the second scaffold branch.

3.10 STAKING

A. Staking of trees shall be done immediately after planting. Plants shall stand plumb after staking. Staking shall be as indicated.

B. No balled and burlapped specimen "tree-like" shrubs shall be staked.

C. Trees of 2-inch caliper and larger shall be guyed at points of branching with 3 wires spaced equally around and outside the perimeter of the ball. Guy wires shall be covered with rubber hose at the bark, protected by approved material at points of contact. Each guy shall be positioned below crotches and fastened to a 4-inch diameter by 18-inch wood deadman, 12-inches below grade. One turnbuckle shall be provided for each guy.

D. Trees less than 2-inch caliper shall be supported by 2 stakes placed diametrically opposite at perimeter line of ball and to sufficient depth to hold tree rigid. Stakes shall be driven vertically and not twisted or pulled. Trees shall be wired to each stake as indicated on staking details. Trees shall be protected with rubber hose over wires at points of contact. Evergreen trees shall be guyed.

3.11 PRUNING AND MULCHING

A. Each tree and shrub shall be pruned in accordance with standard horticultural practice to preserve the natural character of the plant in the manner fitting its use in the landscape design, as approved by the ENGINEER.

B. All dead wood or suckers and all broken or badly bruised branches shall be removed by thinning out and shortening branches. Deciduous bare-rooted plants shall have not less than 1/3 of their respective leaf surfaces removed. All cuts shall be made just above a healthy bud. Pruning shall be done with clean, sharp tools.

C. Cuts over 3/4-inch diameter shall be painted with an approved tree paint. Paint shall cover all exposed cambium as well as other living tissue. Paint shall be waterproof, adhesive, and elastic antiseptic; shall be free from kerosenes, coal tar, creosote, or other materials injurious to the life of the tree; and shall be approved before it is used.

D. Plants shall be mulched after planting and cultivating have been completed. A layer of Top Dressing Mulch materials shall be spread on finished landscaping grade within all planting areas to a depth of 3-inches. The mulch around isolated plants shall be 6 inches greater in diameter than the planting hole. All shrub and ground cover beds shall be completely covered with the mulch.

E. All deciduous tree trunks shall be thoroughly sprayed with a methoxychlor or similar insecticide, and wrapped immediately after planting, with wrapping material overlapping 1-1/2 inches, wound from ground line to the second branch, and securely taped in at least 5 places, including the top, middle, and bottom.

3.12 SEEDING-GENERAL

A. Grass seeds shall be provided where lawn and seeding is indicated and shall be maintained according to “MAINTENANCE OF LANDSCAPING PLANTING PRIOR TO ACCEPTANCE OF PROJECT”, above.

B. The soil shall be prepared and fertilized before seeding or shall be prepared per hydro-seeding instructions. The CONTRACTOR shall prepare only enough ground that can be planted within 24 hours thereafter.

C. Seeding shall be performed between March 1 and May 15, and September 1 through October 15. Seeding outside of the specified window upon approval of ENGINEER

D. Soil preparation shall consist of the following:

1. Preparation of sub-grade grading shall be per paragraphs entitled "General" and "Soil Preparation," respectively, above.

2. Finish grading of soil per paragraph entitled "Soil Preparation", above. The soil additives and fertilizer for finish grading shall consist of compost at 5 cu yd/1000 sq ft and commercial fertilizer at 20lb/1000sq ft.

E. Seed application shall conform to one of the following methods listed below.

3.13 BROADCAST SEEDING

A. Do not commence seeding operation until all requirements of paragraph “Seeding – General” have been approved by the ENGINEER.

B. Sow seed at the rate shown in the seeding table. Equal quantities of seed shall be sown in the directions at right angles to each other to produce an even distribution of seed over the entire area.

C. No seeding shall be done when wind velocity exceeds 4 mph, within 24 hours after rain, or if the surface has been compacted without first loosening the ground.

D. The seed shall then be covered with a fine layer of soil to a depth not greater than 1/4-inch.

E. All lawn areas shall be covered with sphagnum peat moss or clean straw uniformly at a rate of 1-1/2 standard bales per 1000 sq ft.

F. After covering the seeds with soil and peat or straw, the planted area shall be rolled in 2 directions with a 200-lb roller or other roller designed for lawn seeding.

G. All lawn slopes greater than 5 percent, or places where erosion is a problem, shall be mulched with straw at a rate of 2 bales per1000 sq ft., or with approved erosion control matting.

3.14 HYDRO-SEEDING

A. Do not commence seeding operation until all requirements of paragraph “Seeding – General” have been approved by the ENGINEER.

B. This method consists of preparing the seed bed; combining seed mixture at the rate shown in seed table and fertilizer at the rate of 15lb per 1000 sq ft; **"Silva-fiber"** or equal at the rate of 2000-lb per acre of area and water in tanks; agitating these compounds into a well-mixed slurry suspension; and spraying the mixture under pressure onto the prepared areas to be seeded.

3.15 SITE FURNISHINGS

A. BENCHES

1. Obtain Landscape Architect approval for location and placement of benches prior to installation.

2. Install in accordance with manufacturers recommendations

B. TRASH RECEPTACLES

1. Obtain Landscape Architect approval for location and placement of Trash Receptables prior to installation.

2. Install in accordance with manufacturers recommendations

C. PICNIC TABLES

1. Obtain Landscape Architect approval for location and placement of Picnic tables prior to installation.

2. Install in accordance with manufacturers recommendations

3.16 MISCELLANEOUS MATERIALS

A. Gravel shall be placed in the planting areas as indicated, spread carefully and evenly to a minimum depth of 4-inches over the entire area.

B. Cobble shall be hand placed where indicated. Care shall be taken to fill all spaces, placing small cobble in the voids between the large cobble. When complete, CONTRACTOR shall fill all voids with sand and water thoroughly to ensure solid settlement of sand into all cracks and voids. Repeat as necessary to secure cobble from shifting.

C. Landscape Boulders:

1. Shall be placed in field as directed by ENGINEER.

D. Erosion Control Matting: Install Erosion Control Matting on slopes greater thatn 3H:1V or as indicated in the drawings.

END OF SECTION

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SECTION 33 01 30 – TELEVISION INSPECTION OF PIPE

PART 1 -- GENERAL

1.1 DESCRIPTION

A. This specification covers the requirements for internal inspection of sanitary and storm sewers and culverts by closed-circuit television (CCTV). Prior to modification of the fish release pipe, the pipe shall be inspected by CCTV to verify condition and confirm plans for pipe modifications.

B. The work covered in this Section includes furnishing all labor, materials, equipment and services required to hydro-jet clean pipes and perform the CCTV pipe inspections, and the work shall be completed to the latest NASSCO PACP guidelines and reference manual.

C. Inspections shall be performed/documented in accordance with the Pipeline Assessment Certification Program (PACP), current version, administered by the National Association of Sewer Service Companies (NASSCO). Inspection of service laterals shall be in accordance with NASSCO's Lateral Assessment Certification Program (LACP), current version.

1.2 CCTV OPERATOR REQUIREMENTS

A. CCTV operators performing the work shall have undergone NASSCO PACP training and successfully achieved certification. CCTV operators performing service lateral inspections shall have undergone NASSCO LACP training and successfully achieved certification. A current NASSCO PACP/LACP certification shall be provided to the Engineer for each CCTV operator prior to commencement of inspection activities.

B. Each operator must have at least 5 years' experience in performing sanitary/storm sewer CCTV inspections and have completed more than 250,000 ft of sanitary/storm sewer inspections.

1.3 RELATED WORK

A. The requirements of specification section 01 33 00 – Contractor Submittals shall apply to this section.

1.4 SAFETY PROCEDURES

A. The Contractor shall adhere strictly to all State and Federal Occupational Health and Safety Regulations and other construction safety measures. In the event of a discrepancy between such regulations, the most stringent regulation shall apply.

B. Contractor shall be responsible for occupational health and safety on the worksite and ensure that all workers comply with the Owner's safety regulations.

C. The Contractor will serve as "Prime Contractor" for the worksite as it pertains to the applicable Occupational Health & Safety regulation(s).

D. Establish Job Safety Procedures, including a confined space entry procedure including ventilation requirements, and emergency evacuation procedures.

E. Ensure that all personnel entering work area wear the minimum personal protection equipment (PPE) required by the Contractor.

F. AII documents and safety equipment required shall be available for inspection on demand.

PART 2 -- PRODUCTS

2.1 CLOSED CIRCUIT TELEVISION (CCTV) INSPECTION EQUIPMENT

A. Television inspection equipment shall consist of a camera that is self-propelled or mounted on skids and drawn through the pipe by winching, specifically designed for internal inspection of pipes. Operation of the television equipment shall be controlled from above ground by the NASSCO certified PACP/LACP operator controlling the movement of the inspection equipment.

B. Inspection equipment shall be suitable for inspection of sewers ranging in diameter from 6-in to 47-in. Inspection equipment shall be capable of inspecting a length of sewer up to at least 100 ft when entry is possible at only one end and a self-propelled unit is used.

C. Inspection equipment shall contain a means of transporting the camera in a stable condition through the sewer during inspection. Equipment shall allow the camera lens to be positioned in the center of the pipe during inspection and provide an unobstructed view of the pipe interior.

D. Inspection equipment shall include a means to measure the distance of the camera within the pipe and be accurate to within +/- 5.9-in. The distance counter shall be set to zero at the start of each inspection (i.e., at the pipe end insertion point). The distance measurement identifying the camera location in the pipe shall be continuously displayed on the video recording during inspection.

E. Inspection equipment shall have a remotely controlled, adjustable, self-contained lighting system capable of producing at least 100 foot-candles of light. The illumination system must allow an even distribution of the light around the pipe perimeter without the loss of contrast picture, flare out or shadowing. Picture quality shall be such to produce a continuous 500-line resolution color picture showing the entire periphery of the pipe. Picture quality shall be High Definition.

1. The camera unit shall have pan and tilt capability.

2. The pan and tilt camera shall be able to pan the pipe at 360 degree with tilt capability of 275 degree to ensure complete inspections and view of all laterals and deficiencies.

F. Each survey unit shall contain a means of transporting the inspection equipment in a stable condition through the pipeline. Electrical power for the system shall be self-contained and shall not require removal for each set-up. External power sources from public or private residences shall not be permitted.

G. Where the survey unit is towed by winch and cable through the pipeline, all winches shall be stable during the entire inspection. All cables shall be of steel or of an equally non-elastic material to ensure the smooth and steady progress of the CCTV camera.

H. Each unit shall carry sufficient number of guides and rollers such that, when surveying, all cables are supported away from pipe and maintenance hole edges. All CCTV cables and lines used to measure the camera's location within the pipeline shall be maintained in a

taut manner and set at right angles, where possible, to run through or over the measuring equipment.

PART 3 -- EXECUTION

3.1 PROCEDURE

A. Video inspection shall be performed of the pipe in a dewatered condition without flowing water. Contractor must provide the Owner 72 hours' notice prior to planned CCTV inspection, in order to drain the Lower Pond for access to the Fish Release Pipe.

B. The Contractor is advised that the downstream invert of the Fish Release Pipe is at an elevation approximately equal to the mean low tide and is therefore typically submerged during most times of the day throughout the year. CCTV inspections shall not be performed when the water depth in the pipe exceeds 1-inch. The Contractor shall provide flow control plan, detailing the flow control approach (either by temporary cofferdam, bypass pumping, and/or temporary pipe plugging), to reduce the water level in the pipe to an acceptable depth. The plan shall be submitted to the Engineer for review and approval. Excessive water depths in localized areas within the pipe (such as those caused by sags, debris/obstructions, encrustation, etc.) shall be evacuated to reduce water levels to an acceptable depth during CCTV inspection. Contractor shall be responsible for any cleanup, damages, and regulatory fines caused by their flow control work.

C. Pipes shall be pre-cleaned prior to CCTV inspection, unless directed otherwise by the Engineer.

D. The CCTV inspection shall document a complete visual survey of the pipeline from access point to access point, unless directed otherwise by the Engineer.

E. Where pipe conditions or equipment limitations prevent the camera from advancing in the pipe, the inspection shall be documented as abandoned and a reverse inspection performed. A reverse inspection shall be performed by insertion of the camera equipment in the opposite access structure on the pipe and advancing to the point of abandonment of the initial inspection.

F. The pipe ID designated by the Owner shall be utilized to document pipe inspections and shall be displayed on the recorded inspection video. If during the inspection, a buried manhole is discovered that is not identified in the Owner's asset inventory, the Contractor shall notify the Engineer to obtain a temporary ID designation for the manhole and affected pipes. The temporary designation shall be used in inspection deliverables and shall be displayed on the video recording for the affected pipe(s).

G. The location of defects and observations shall be referenced as the distance from the inside face of manhole/access structure. The total recorded inspection length shall be measured as the distance between the inside face of the upstream and downstream manholes/access structures. For storm culverts, the pipe length shall be documented as the distance between the face of the connecting headwalls, or in the case of pipes projecting from fill, as the distance between pipe ends. For incomplete inspections, the total recorded inspection length shall be measured from the inside face of the manhole/access structure to the location the inspection was abandoned.

H. The Contractor shall submit to the Engineer, certification of the accuracy of the automatic distance counter prior to the start of inspection activities. If, at any time, the Engineer has reason to believe that the distance counter is inaccurate, the calibration of the counter will

be checked before additional inspections are performed. Inspections where the distance counter is not functioning properly shall not be accepted.

I. The camera unit shall be advanced through the pipe at a uniform rate, stopping when necessary to properly document pipe condition. In no case shall the television camera be advanced at a speed greater than 30 ft per minute.

J. The camera operator shall, during the inspection, pan/tilt the camera to focus on construction features and defect observations in the pipe. The camera should be stopped at each tap connection and positioned to allow the lateral pipe interior to be clearly visible. The camera should provide a clear view of the entire connection, panning and tilting as necessary, to allow for assessment of its condition. For joints, the camera should trace the full circumference of the joint connection to assess its condition and if it is properly seated.

K. Defects and observations shall be documented in accordance with NASSCO's PACP, current version. For lateral inspections, defects and observations shall be documented in accordance with NASSCO's LACP, current version.

L. Data collection software utilized to document CCTV inspections shall be certified by NASSCO for PACP/LACP inspections. Data collection software shall be capable of exporting inspection information in NASSCO's PACP/LACP Standard Exchange Database format.

M. Snapshot/still photographs of each defect, tap/connection and observation shall be collected during the inspection.

N. The Contractor shall notify the Engineer immediately if a utility cross bore through the pipe is observed during the inspection.

O. At the start of each inspection, the camera shall be positioned in the manhole and the lens turned upward to provide an interior view of the manhole walls, cone and chimney. If the complete circumference of the manhole is not visible, then the camera pan/tilt/zoom features shall be used to allow for a complete view of the manhole walls/interior. At the conclusion of the inspection, the process should be repeated to provide an interior view of the opposite manhole/access structure.

P. To minimize the length and file size of inspection videos, recording shall be paused when inspections are temporarily halted. Video recordings shall begin again when the inspection resumes. The camera shall not be advanced in the pipe when the video recording is paused.

Q. The camera lens shall be kept clean at all times during the inspection.

R. The meter reading entered on to the data display at the cable calibration point shall allow for the distance from the start of the survey to the cable calibration point such that the meter reading at the start of the survey is zero.

S. In the case of surveying through a manhole where a new header sheet is required, the meter reading shall be set at zero with the camera focused on the outgoing pipe entrance.

T. At the start of each pipe inspection, the video recording shall clearly display the following minimum information: a

1. Pipe ID (as provided by the Owner)

2. Date of survey

3. Weather

4. Pipeline dimensions (height and width or diameter).

5. Pipe material

6. Pipe shape

7. Upstream and Downstream Manhole IDs (as provided by the Owner)

8. Nearest Address

9. Direction of survey

10. Time of start of survey.

11. Inspection technician or operator

3.2 QUALITY CONTROL

A. Upon submission, printed and digital inspection reports, digital MPEG video recordings, and coding accuracy checks shall be reviewed to ensure compliance with the Contract Documents.

B. Submittals shall be reviewed by the Contract Administrator and their acceptance confirmed within 10 Business Days of submission. Only inspections with minimum accuracy for header information of 95 percent, and minimum detail accuracy for defects and features of 85% will be accepted. Non-compliant submissions will be returned for correction. Corrected submissions must be returned to the Contract Administrator for review. No payment shall be made to the Contractor until the submissions have successfully passed Engineer's QAQC review.

C. Operators failing to meet the coding accuracy requirements on two occasions shall not be permitted to code on the remainder of the Contract.

PART 4 -- DELIVERABLES/SUBMITTALS

4.1 GENERAL

A. All supplied data and information will become the property of the Owner.

B. All deliverables shall utilize the pipe IDs designated by the Owner.

4.2 SUBMITTAL:

A. At the completion of all inspection work, the Contractor shall supply the following to the Engineer on an external hard drive:

1. A single, consolidated NASSCO PACP Standard Exchange Database in Microsoft Access (.mdb) file format containing all inspections. Inspections in the database should reflect any changes made to intermediate submittals as a result of QA/QC reviews.

2. Media files (observation photos and CCTV videos) for inspected pipe

3. A Pipe Inspection Report, in PDF format, for each inspected pipe

4. A summary table indicating the pipe IDs of each inspected pipe, surveyed length, whether pipe was fully or partially inspected, and if the inspection is a reverse inspection.

5. Inspections that did not successfully pass the Engineer's QA/QC review shall not be included in the Final Submittal.

B. Final submittals shall also be supplied to the Engineer on an external hard drive or thumb drive.

END OF SECTION

SECTION 33 05 16 - PRECAST CONCRETE MANHOLES AND VAULTS

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall provide precast concrete vaults, complete and in place, in accordance with the Contract Documents.

1.2 SPECIFICATIONS, CODES AND STANDARDS

ASTM A 48	Gray Iron Castings
ASTM C 150	Portland Cement
ASTM C 478	Precast Reinforced Concrete Manhole Sections
ASTM C 890	Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures
ASTM C 913	Standard Specification for Precast Concrete Water and Wastewater Structures
ASTM C 923	Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals

1.3 CONTRACTOR SUBMITTALS

A. **General:** Furnish submittals in accordance with Section 01 33 00 – Contractor SubmittalS.

B. Shop Drawings

1. Show dimensions, locations, lifting inserts, reinforcement, and joints.

2. Structural design calculations for vaults, stamped and signed by a registered engineer.

C. Manufacturer's Certification for Vaults: Written certification that the vault complies with the requirements of this Section.

D. **Manufacturer's Test Results:** Pull out force for manhole steps.

1.4 QUALITY ASSURANCE

A. **Inspection:** After installation, the Contractor shall demonstrate that manholes and vaults have been properly installed, level, with tight joints, at the correct elevations and

orientations, and that the backfilling has been carried out in accordance with the Contract Documents.

PART 2 -- PRODUCTS

2.1 MANHOLES AND CATCHBASINS

A. The Contractor shall provide precast manhole sections and conical sections conforming to ASTM C 478 and the requirements of this Section. Adjusting rings shall be standard items from the manufacturer of the manhole sections. Minimum wall thickness of rings shall be 4-inches if steel reinforced and 6-inches if not reinforced.

B. Axial length of sections shall be selected to provide the correct total height with the fewest joints.

C. **Design Criteria:** Manhole walls, transitions, and base shall be designed per ASTM C 478 for the depths indicated and the following:

1. AASHTO H-20 loading applied to the cover.

2. Unit weight of soil of 120 pcf located above all portions of the manhole.

3. Lateral soil pressure based on saturated soil producing 100 pcf acting on an empty manhole.

4. Internal fluid pressure based on unit weight of 63 pcf with manhole filled from invert to cover with no balancing external soil pressure.

5. Dead load of manhole sections fully supported by the base and transition.

6. Additional reinforcing steel in walls to transfer stresses at openings.

7. The minimum clear distance between the edges of any 2 wall penetrations shall be 12-inches or one-half of the diameter of the smaller penetration, whichever is greater.

D. Joints shall be sealed with o-ring gaskets conforming to ASTM C 443.

E. Concrete for base and channel formation shall be 4000 psi concrete conforming to Section 033100 - Cast-In-Place Concrete.

F. Barrel section to pipe connections shall be sealed with resilient connectors complying with ASTM C 923. Mechanical devices shall be stainless steel.

G. Manhole steps shall be comprised of 1/2-inch grade 60 steel reinforcement rod encased in polypropylene copolymer plastic. Steps shall have tread width of 14-inches. Furnish test results demonstrating step capability to resist a pull out force of 2200 pounds. Provide **PS2-PF Manhole Step** by **M.A. Industries,** or equal.

H. Manhole Manufacturers, or Equal

1. **Jensen Precast**

2. **Oldcastle Infrastructure**

3. **H2 Pre-Cast**

2.2 FRAMES AND COVERS

A. **Castings:** Castings for manhole frames and covers shall be non-rocking and shall conform to the requirements of ASTM A 48, Class 30. Unless otherwise indicated, cast iron covers and frames shall be heavy traffic type, 30 inches in diameter. Frame and cover shall be designed for H-20 traffic loading.

B. Castings Manufacturers, or Equal

1. **Alhambra Foundry Co., Ltd.**

2. **Neenah Foundry Co.**

3. **Vulcan Foundry, Inc**

2.3 VAULTS

A. The Contractor shall provide precast vaults designed for the indicated applications and of the sizes indicated. Dimensions shown in the vault schedule are internal opening dimensions.

B. The minimum structural member thickness for vaults shall be 5-inches. Cement shall be Type V portland cement as specified in ASTM C 150. The minimum 28-day concrete compressive strength shall be 4,000 psi. All reinforcing steel shall be embedded in the concrete with a minimum clear cover as recommended by ACI 318.

C. Design Loading: Vaults in areas subject to vehicular traffic shall be designed for H-20 traffic loading. Vaults in other areas shall be designed for a vertical live load of 300 psf. Lateral loads on vaults in all areas shall be calculated from:

	L	=	90 h, plus surcharge of 240 psf in areas of vehicular traffic
Where	L	=	loading in psf
	h	=	depth of fill in feet

D. Where joints are designed in pre-cast concrete vaults, such joints shall be interlocking to secure proper alignment between members and prevent migration of soil through the joint. Structural sections at joints shall be sized sufficiently to reinforce the section against localized distress during transportation and handling and against excess contact bearing pressures through the joint.

E. Where openings for access to the vault are required, the full clear space opening indicated shall be provided, without obstructions from brackets or supports.

F. Covers for access openings shall be provided. Frames for covers shall be fabricated from steel, galvanized after fabrication, and shall be integrally cast into the vault concrete sections. All covers shall be tight fitting to prevent the entrance of dirt and debris. Where edge seams are permitted, no gaps greater than 1/16-inch between edges will be accepted. All covers, except round, heavy-weight, cast iron manhole covers, shall have securing mechanisms to hold the covers firmly in place against the effects of repetitious live loads such as pedestrian or vehicle traffic.

G. Where penetration of the pre-cast concrete vault are required for piping, conduit, or ducts, such penetrations shall be accommodated through pre-cast openings or thin-wall knock-out sections. All openings for penetrations shall be smooth and free of surface irregularities and without exposed steel reinforcing. Vaults need not be designed to resist thrust from piping passing through the vault.

PART 3 -- EXECUTION

3.1 GENERAL

A. Pre-cast concrete sections shall be transported and handled with care in accordance with the manufacturer's written recommendations. Where lifting devices are provided in pre-cast sections, such lifting devices shall be used as intended. Where no lifting devices are provided, the Contractor shall follow the manufacturer's recommendations for lifting procedures to provide proper support during lifting.

B. Buried pre-cast concrete vaults shall be assembled and placed in excavations on properly compacted soil foundations as indicated. Pre-cast concrete vaults shall be set to grade and oriented to provide the required dimensions and clearances from pipes and other structures.

C. Prior to backfilling, all cracks and voids in pre-cast concrete vaults shall be filled with non-shrink grout or polyurethane sealant, or both. Around pipe and conduit penetrations, openings shall be sealed with polyurethane sealant. With the authorization of the Engineer, grout or a closed-cell flexible insulation may be used as filler material prior to placing a final bed of polyurethane sealant.

D. Ladder shall be driven into tapered holes formed in the concrete by inserts from the ladder manufacturer or 1-inch holes drilled 3-3/4 inches deep into the manhole wall in the field. No more than 6-1/8 inches of plastic arm, measured on the inside of the step, shall be exposed outside the concrete.

E. Ladder shall be installed 12-inches on centers vertically, not more than 1/2 inch out of plumb. The top step shall be no more then 12-inches below the manhole or vaultcover.

F. Hatch dimensions and load rating requirements are shown on the vault schedule of the Contract drawings.

END OF SECTION

SECTION 33 83 00 - LANDSCAPE IRRIGATION

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall design and provide a permanent automatic irrigation system, complete and operable, and a Temporary on-surface automatic irrigation system for seeded grass areas in accordance with the Contract Documents.

B. The CONTRACTOR shall coordinate with Tulalip Utility Authority for connection to existing water meter and installation of backflow prevention equipment in accordance with local code.

C. Minor items necessary for proper construction and functional operation of the system, even if not specifically described in the Contract Documents, shall be included as a part of the WORK of this Section.

D. The CONTRACTOR shall operate and maintain, including seasonal winterizing, and startup of the irrigation system for a period of 2-years after Acceptance of the WORK of this Section.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 013300 - Contractor Submittals.

B. Shop Drawings

1. Shop Drawings of the complete irrigation system and irrigation structures, including valve sizes, pipe sizes and flow calculations in gallons per minute for control valves. CONTRACTOR is responsible for the detailed design of the irrigation system in accordance with the requirements of the Contract Documents. The detailed design shall be submitted to the ENGINEER for approval prior to commencing WORK.

2. Complete list of irrigation materials and equipment, including manufacturer's name/address, specific trade names, catalog numbers, complete with illustrations and/or necessary descriptive literature. The proposed items shall be clearly marked or underlined.

3. Controller literature, specifications, installation wiring diagram, and circuit breaker information shall be submitted for review prior to ordering.

C. **Record Drawings:** Record drawings showing locations of all valves, pipe, heads, dimensions, controllers, control cables, and electrical wiring shall be submitted to the ENGINEER prior to final inspection.

1.3 QUALITY ASSURANCE

A. The CONTRACTOR shall give at least 72 hours notice to the ENGINEER for scheduling the following special inspections:

1. Layout of the system

2. Inspection of trenches, backfilling, and equipment.

3. Pressure tests

4. Coverage adjustment

5. Automatic operation

B. **Pressure Testing:** Tests shall be performed in the presence of the ENGINEER.

1. After assembly and installation, water pipes, fittings, automatic equipment, and appurtenances shall be tested at a hydrostatic pressure of 150 psi at the lowest point of the system for not less than 60 minutes.

2. The first test shall be made in such a manner that all valves in the new water pipe sprinkler lines will be tested for watertight closure. Valves may be tested in groups or singly while subjected to 150 psi water pressure for a period of not less than 60 minutes.

3. The second test shall be made by forcing air from the pipes with water and capping or plugging pipe risers. After the pipe risers have been plugged or capped, line valves shall be fully opened, and the pipelines subjected to the full static water pressure for a period of not less than 120 minutes. (Pressure pipelines 150 psi).

4. The third test requires that lateral lines be tested at 100 psi for 15 minutes.

5. The fourth test requires that all pressure lines be tested at 120 psi for 24 hours.

6. Water lines and valves which show evidence of leakage or fail to be watertight shall be repaired or replaced. After all repairs or replacements have been made, the above tests shall be performed again.

C. **Coverage Adjustment:** When the sprinkler system is completed, the CONTRACTOR, in the presence of the ENGINEER, shall demonstrate coverage of water onto the lawn and planting areas. The CONTRACTOR shall furnish all material and perform all WORK required to correct any inadequacies of coverage disclosed. The CONTRACTOR shall inform the ENGINEER of any deviation from the Drawings required due to wind, planting, soil, or Site conditions that bear on proper coverage.

1. Upon completion of each phase of the WORK, the CONTRACTOR shall check and adjust each sprinkler head to meet the Site requirements of the Contract Documents.

1.4 SCHEDULING AND COORDINATION

A. The CONTRACTOR shall be responsible for making arrangements for the coordination of its construction operations with those of all others on the Site. The CONTRACTOR shall permit others engaged in work on the Site to accomplish their work without undue interference or delay.

B. The CONTRACTOR shall be responsible for the scheduling and coordination of the electrical and water connections and the installation of the piping and equipment in a manner that will affect the earliest completion of the WORK in conformance with the construction progress schedules.

1.5 SPECIAL CORRECTION OF DEFECTS REQUIREMENTS

A. The CONTRACTOR shall repair any settling of backfilled trenches occurring during a one-year period after final acceptance without expense to the OWNER including complete restoration of all damaged planting, paving, or other improvements of any kind.

B. The CONTRACTOR shall provide winterization of the irrigation system during the one-year period if necessary.

C. When defective material or workmanship is discovered which will require repair or replacement, such repair or replacement shall be completed by the CONTRACTOR within 3 Days after written notification of such required repair is given by the OWNER. However, if the CONTRACTOR fails to comply after notification is given, the OWNER will proceed to have the repairs made by others at the CONTRACTOR's expense.

PART 2 -- PRODUCTS

2.1 GENERAL

A. **Equipment Compatibility:** Controller and automatic control valves shall be products of the same manufacturer and have similar operational and adjustment features.

2.2 PLASTIC PIPE AND FITTINGS

A. Pipe shall be continuously and permanently marked with the manufacturer's name, nominal pipe size, PVC type, pressure rating, and extrusion date. Pipe shall be as recommended for the intended application.

B. Lateral lines shall be PVC SDR 21, Schedule 40

C. Piping upstream from remote control valves and quick coupling lines shall be PVC SDR 21, Schedule 40, NSF approved, or galvanized steel pipe in accordance with Section 431053. Galvanized steel pipe shall have joints of standard size and length. Joints on PVC piping larger than 3-inches diameter shall be O-ring type flexible couplings and on size 3-inches and smaller shall be solvent welded.

D. Fittings shall be PVC Schedule 40, Type II, NSF, or Schedule 80 as indicated.

E. Swing joint ells shall be Schedule 80 PVC. Flexible riser shall be 1/2-inch in size as manufactured by **Flex-Nipple, Model No. UP-90 and UP-180** or equal.

F. Teflon thread tape sealant shall be **Rectorseal No. 5** or equal., 3/4-inch wide.

2.3 VALVES

A. **General:** Hose bibb valves of size 3/4-inch shall be provided in accordance with Section 221010 - Plumbing Specialties, with permanent metal signs at noticeable locations. Signs shall be 5-inches by 3-inches in size and read as indicated. The signs shall be permanently fastened to pipe, post, or wall at hose bibb.

B. Main shut-off valves shall be bronze gate valves with union bonnet, renewable seats, and non-rising stem, Class 150, or better. Gate valves shall be provided with 2-inch square operating nuts.

C. Isolation valves for main lines shall be bronze gate valves with wedge disc, Class 125, screwed ends, and operating nut, as manufactured by **Rainbird, Buckner, Toro**, or equal.

D. **Remote Control Valves:** Remote control valves for the irrigation system shall conform to the following requirements:

1. For Permanent Drip Irrigation: Rainbird XCZ-150-PRB-COM Commercial Medium Flow control valve fitted with 9 volt electrically controlled solenoids, dc operation or approved equal. Each remote-control valve shall be housed in a valve box. The box shall be of adequate size and be set in clean gravel.

2. For Temporary On-Surface Spray Irrigation: Control valves shall be Rainbird DV/DVF Series control valve fitted with 9 volt electrically controlled solenoids, dc operation or approved equal. Each remote-control valve shall be housed in a valve box above ground.

E. Refer to the Shop Drawings for approved manufacturer's name, model number, and size Quick-coupling valves shall be products of the same manufacturer as the sprinklers.

F. Quick-coupling valves shall be products of the same manufacturer as the sprinklers.

2.4 AUTOMATIC CONTROLLER

A. Controllers shall be electrically timed devices for automatically opening and closing remote control valves. Controllers and remote-control valves shall be of the same manufacturer and have similar operational and adjustment features.

B. Controller(s) shall be Toro DDCWP-Series, 8 Station, 9V battery powered, or Rainbird EPS-9V, 6 station controller or approved equal.

C. Controllers shall be adjustable so that each control valve in the circuit will remain open for an adjustable period of 5 or less minutes to 60 minutes. Readily made field adjustments shall include a provision whereby any number of days in a week can be skipped and whereby one or more positions on the controller may be skipped. When any or all of the above adjustments have been made, the controller shall continue to operate automatically until further adjustments are made. Provision shall be made for conveniently resetting the start of the irrigation cycle at any time and also for advancing from one position to any other position at will.

D. The controller shall be enclosed as detailed on the Shop Drawings.

2.5 ON-GRADE IRRIGATION SPRINKLER HEADS AND NOZZLES

A. Sprinkler heads and nozzles shall be as detailed on the Shop Drawings.

B. Rotor pop-up sprinklers shall be gearing driven rotary heads. Rotation shall be accomplished by a sealed, oil packed gear assembly isolated from the water supply. The sprinkler housing shall be of high impact molded plastic with a 3/4-inchNPT connection. The sprinkler shall be capable of installation at grade level. Heads shall have adjustable arc increments. Provide **Rainbird, Toro, Hunter**, or equal.

C. Spray heads shall be pop-up design or fixed risers, full or part circle. The sprinkler shall have a riser screen filter to prevent entry of foreign material to the nozzle. All parts shall

be removeable through the top of the sprinkler case. Pop-up sprinkler heads shall have a stainless-steel retraction spring. Provide **Rainbird, Toro, Hunter**, or equal.

2.6 SHRUB AREA DRIP IRRIGATION SYSTEM

A. Drip Emitter pipe and fittings.

1. Drip irrigation shall be as detailed on the Shop Drawings.

2. The dripline tubing shall be Rainbird XFS and XFD Dripline with the Copper Shield technology or approved equal. See plan for the output requirements and the spacing of the welded emitters inside the tubing.

2.7 CONTROL WIRING

A. Control wiring shall be Standard UF Direct Burial Copper Wire, Type UF Bearing, UL approved for direct underground burial in National Electrical Code Class II circuits, AWG sizes.

B. Conductors shall be grading copper meeting ASTM B 3 - Soft or Annealed Copper Wire.

C. Splices shall be made with wire connectors, such as manufactured by **Rainbird, Pen Tit, Scotch Lock,** or equal.

2.8 PVC SOLVENT CEMENT AND PRIMERS

A. Solvent cement shall be NSF approved and shall meet requirements of ASTM D 2564 - Solvent Cements for Poly Vinyl Chloride (PVC) Plastic Pipe and Fittings.

B. Primer shall be NSF approved and shall be **Weld-On, P-70 Industrial Polychasia Service,** or equal.

2.9 WORM GEAR CLAMPS

A. Worm-gear clamps shall be stainless steel.

2.10 VALVE AND CONTROLLER BOXES

A. Boxes for valves and controllers shall be heavy duty fiber glass and shall be complete with lid. Boxes shall be sized for equipment within box, depth of installation, and operation and maintenance space required. Lid shall identify equipment inside box, such as RCV for remote control valve, etc.

2.11 SPARE PARTS

A. Furnish the following:

1. Four control valve operating keys.

2. Two gate valve keys.

PART 3 -- EXECUTION

3.1 EXISTING CONDITIONS

A. Prior to trenching, the CONTRACTOR shall locate all cables, conduits, sewers, septic tanks, and other such underground utilities, and shall take proper precautions not to damage or disturb such improvements. If a conflict exists between such obstacles and the proposed WORK, the CONTRACTOR shall promptly notify the ENGINEER.

B. The CONTRACTOR shall be responsible for coordinating its work with the operation of existing utilities and new utilities on the Project. The CONTRACTOR shall notify the ENGINEER or its representative when operating utilities require shut-off.

C. Due to the scale of Drawings, it is not possible to indicate all offset fittings, etc., which may be required. The CONTRACTOR shall carefully investigate the structural and finished conditions affecting all its WORK, and plan, accordingly, providing such fittings, etc., as may be required to meet such conditions. The Contract Documents are generally diagrammatic and indicative of the WORK to be installed. The WORK shall be installed in the most direct and workmanlike manner, so that conflicts between sprinkler systems, planting, structures, and piping, will be avoided.

D. The CONTRACTOR shall verify the water pressure available at the Site before installation of the system to make sure there is adequate pressure (design pressure 65 psi) to properly operate sprinkler heads and valves and shall also provide pressure reducing valves if required. If the pressure at Site or any other job condition will create problems that will prevent proper operation of the irrigation system, the ENGINEER shall be notified before commencement of any WORK. Minor additions and adjustments of heads, piping, and circuits shall be made at no additional cost to OWNER where it is necessary to make the irrigation system operate properly.

3.2 EXECUTION - GENERAL

A. Installation of the irrigation system shall be performed after the finish grading, but prior to landscaping.

B. Valves, fittings, heads, and piping shall be installed as indicated and all connections made to permit the irrigation system to function properly through its entire length.

C. Materials and equipment shall be installed in strict accordance with manufacturer's written instructions and recommendations and all local and state codes, laws, ordinances, and regulations.

D. Before proceeding with the installation of any section or unit of the irrigation system, the CONTRACTOR shall check and verify the correlation between ground measurements and Drawings and shall advise the ENGINEER of any discrepancies.

3.3 EXCAVATION

A. Trenches shall be dug as wide and as deep as necessary to properly install the irrigation lines. Width shall allow for proper tamping of backfill around the pipe.

B. Pipe trenches shall be straight or "snaked" slightly allowing for expansion and contraction of PVC pipe.

C. Subsoil shall be kept separate from topsoil, where possible.

D. Minimum cover depth shall be:

1. Supply pressure lines from water source to control valves: 24-inches unless otherwise indicated.

2. Lateral lines from control valves to sprinkler heads; 18-inches unless otherwise indicated. Lateral lines under paving, roadways, and driveways shall have 24-inches of cover and be located in Schedule 40 PVC sleeves.

3. Trenches for control wire only shall be 18-inches deep unless otherwise indicated. Control wires under concrete walks and slabs, paving, roadways, and driveways shall be installed in Schedule 40 PVC sleeves.

3.4 PIPING -GENERAL

A. Piping shall be laid out and installed in accordance with manufacturer's printed recommendations and industry standards. Substantial support shall be provided at all points, and pipes shall be snaked slightly allowing for expansion and contraction.

B. Minimum one-inch vertical clearance shall be between lines crossing at angles greater than 45 degrees.

C. Horizontal and vertical clearances between all lines shall be minimum 3-inches.

D. Swing or swivel joints shall provide a leak-resistant joint with freedom of movement.

E. Teflon thread sealant shall be used at threaded joints.

F. Galvanized steel pipes shall have clean standard threads of standard lengths. Joints shall be made up with pipe compound applied to male threads only and not more than 2 threads shall show at the joints when connected.

G. Pipe sleeves shall be provided under all paving and where necessary for passage under finish surface material, future replacement, and for protection of PVC piping and control wire. Pipe sleeves shall extend at least 12-inches beyond the edge of pavement.

3.5 PLASTIC PIPE

A. The plastic pipe sections shall be placed accurately to line and grade in the prepared trenches. The inside of all pipes shall be clean and free from foreign matter and shall be end-reamed to remove burrs and provide full inside diameter of the pipe end.

B. Pipe shall have a firm, uniform bearing for the entire length of each pipeline to prevent uneven settlement. Adjustments to grade shall be made by scraping away or filling in with clean earth backfill material, well compacted under the body of the pipe. Wedging of pipe will not be permitted. The inside of pipe shall be clean and free from foreign materials before joints are assembled.

C. Open pipe ends where the WORK has been stopped shall be closed at the end of each day's construction work with a suitable temporary plug to prevent entrance of any foreign materials into the assembled pipeline.

D. Pressure pipe shall be defined as all piping lying "upstream" from remote control valves and quick-coupling lines.

E. O-Ring type flexible coupling pipe shall be used on pressure pipes larger than 3-inches diameter.

F. Three-inch and smaller mainlines and fittings of pressure piping shall be solvent-weld type.

G. Pressure piping 3-inches and larger shall be provided with portland cement concrete thrust blocks. Thrust blocks shall be constructed at the following places:

1. Were pipe changes direction at fittings.

2. Where pipe changes size.

3. Where line terminates.

4. Around gate valves (bottom half of valve in concrete; bolts exposed for change of top half).

H. Thrust blocks shall be constructed of 2000 psi concrete, as follows:

THRUST BLOCKS

Pipe Size	Minimum Square Feet of Bearing Area			
	Dead Ends, Tees, or Valves	90 Degree Bends	45 Degree Bends	22-1/2 Degree Bends or Less
3-inches	1.1	1.5	0.8	0.4
4-inches	2.0	2.7	1.5	0.7

I. The areas given in the table shall be measured in a plane perpendicular to the longitudinal axis of the pipe or to the longitudinal axis of the thrust developed. The thrust block bearing area shall be against undisturbed ground.

3.6 VALVES

A. Valves shall be the full size of the line in which they are installed, unless otherwise indicated.

B. Remote control valves shall be enclosed in valve boxes: up to 3 valves may be installed in one box if dimensions permit. Valves shall be adjusted so the most remote sprinkler heads operate at the pressure recommended by the head manufacturer and so a uniform distribution of water is applied by the sprinkler heads to the planting areas. A metal union shall be provided on the discharge side of the control valve. They shall be wired to operate in the order indicated.

C. Hose bibbs shall be installed as indicated.

D. Gate valves shall be properly blocked to a cast-iron water works valve box. One 5-foot wrench for each 3 gate valves shall be furnished.

E. Quick-coupling valves shall be provided, with one-inch swing joint in the same manner as the pop-up sprinklers. Quick-coupler lines shall be installed not less than 18-inches below grade.

F. A main stop and drain valve shall be installed near the point of connection to the main line.

G. Drain valves shall be installed at low points along the main. It shall be the CONTRACTOR's responsibility to see that the main drains properly.

H. Gravel sumps 2-feet by 2-feet by 2-feet in size and filled with 3/4-inch to one-inch size round gravel shall be provided at each manual drain valve and at low sprinkler head locations for drainage, (spray heads only).

3.7 VALVE BOXES

A. Valve boxes shall be set 1/2-inch above the designated finish grade in lawn areas and 2-inches above finish grade in ground cover areas.

3.8 SPRINKLER HEADS

A. Nozzles on sprinklers shall be tightened after installation. Sprinklers having an adjustment stem shall be adjusted on a lateral line for the proper radius diameter and/or flow rate.

B. Sprinkler heads shall be set perpendicular to finished grades and at finish ground level unless otherwise indicated.

C. Emitters shall be coordinated with actual field placement of shrubs as directed by the ENGINEER.

D. The sprinkler system shall be thoroughly flushed as so to remove all possible foreign matter prior to installation of the sprinkler heads.

E. The CONTRACTOR shall protect against re-entry of contaminated water into risers or piping. After flushing, the CONTRACTOR shall immediately install sprinkler heads or cap risers until sprinkler heads are installed.

3.9 CONTROLLERS

A. Controller location on the Drawings is essentially diagrammatic, and the actual installation shall be as specifically located by the ENGINEER.

3.10 WIRING

A. Electrical equipment and wiring shall comply with applicable codes and shall be installed by those skilled and licensed in the trade.

B. The CONTRACTOR shall provide low voltage, 24-volt direct burial wires of not less than No. 14 AWG. Where sizes are not indicated, they shall be sized per wire manufacturer's sizing charts and specifications.

C. The CONTRACTOR shall provide all wiring, conduits, sleeves, and connection for the low voltage electrical system between controller and valves where indicated and necessary for a complete and operable irrigation system.

D. Wires shall be color coded as follows:

1. Control wires shall be red.

2. Ground (neutral) wire shall be white.

E. Splices shall be moisture proof using appropriate electrical connectors.

F. Wires shall be bundled together and wrapped with PVC tape at 5-foot intervals. They shall be buried in same trench as the pipe where possible.

G. An expansion curl shall be provided within 3-feet of each wire connection and at least every 100-ft of wire length on runs more than 100-feet in length. Expansion curls shall be formed by wrapping at least 5 turns of wire around a one-inch pipe or more in diameter, then withdrawing pipe.

H. Conduits and sleeves necessary for running wires under concrete, walks, and paving shall be provided before concrete, walks, and paving work is constructed. Changes in conduit and sleeve direction under paving shall be made with sweep ells.

I. Wire shall be continuous without splices except at control valves and shall be routed in main line trench whenever possible.

3.11 PIPE TRENCH BACKFILL

A. Bottom of trenches shall be smooth and free of sharp rocks and other objects that may damage pipe.

B. Backfill material shall be free of rocks and other materials that may damage the piping.

C. The initial backfill shall be accomplished by carefully tamping selected material (from material excavated from the trench) under the pipe and between the pipe and the trench walls.

D. The pipes shall be filled with water and pressurized during backfilling operations, if necessary, to prevent drainage into piping.

E. The backfill shall be carefully installed around and over the pipe to approximately 10-inches of the ground surface, then water shall be allowed to flow in the trench. After this puddling operation has been completed and allowed to stand for 24 hours, the balance of the materials shall be placed in the trench to the sub-grade line, leaving room for topsoil. The backfill shall be compacted carefully and thoroughly.

F. Couplings and fittings shall be left exposed until leakage tests have been completed, unless the ENGINEER orders otherwise.

G. Topsoil shall be installed prior to planting.

3.12 TESTING AND ADJUSTMENTS

A. The sprinkler heads shall be adjusted and balanced for optimum and uniform coverage without excessive fogging and overthrow on walks, paving, and structures. The height and elevations of risers and sprinkler heads shall be adjusted.

B. Following adjusting and balancing of the sprinkler heads, an operating test of the entire system shall be performed by the CONTRACTOR in the presence of the ENGINEER at

normal operating pressures. The test will be considered as acceptable if the system operates in a satisfactory manner providing uniform coverage of irrigated areas for a one-week period of automatic operation with no leaks.

3.13 INSTRUCTION

A. The CONTRACTOR shall, upon completion of the maintenance period of the irrigation system, instruct the OWNER and the OWNER's personnel as to the proper operation and maintenance of the system.

END OF SECTION

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SECTION 33 92 20 - DUCTILE IRON PIPE AND FITTINGS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The Contractor shall provide ductile iron pipe and appurtenant Work, complete and in place, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

AWWA C104	Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C105	Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C110	Ductile-Iron and Gray-Iron Fittings, 3 in through 48 in for Water
AWWA C111	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C115	Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges
AWWA C116	Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings for Water Supply Service.
AWWA C150	Thickness Design of Ductile-Iron Pipe
AWWA C151	Ductile-Iron Pipe, Centrifugally Cast for Water
AWWA C153	Ductile-Iron Compact Fittings. for Water Service
AWWA C600	Installation of Ductile Iron Water Mains and Their Appurtenances
AWWA C606	Grooved and Shouldered Joints
ASTM C 150	Portland Cement

1.3 CONTRACTOR SUBMITTALS

A. Furnish Submittals in accordance with Section 01 33 00 - Contractor Submittals and the following supplemental requirements:

B. Shop Drawings

1. Certified dimensional drawings of valves, fittings, and appurtenances.

C. Certifications: Certified affidavit of compliance for pipe and other products or materials furnished under this Section and as specified in the referenced standards and the following supplemental requirements:

1. Physical and chemical properties.

2. Hydrostatic test reports.

D. The Contractor shall be responsible for performing and paying for sampling and testing as necessary for the certifications.

1.4 QUALITY ASSURANCE

A. Tests: Except as modified herein, materials used in the manufacture of the pipe shall be tested in accordance with the requirements of the referenced standards as applicable.

B. The Contractor shall perform said material tests as part of the Work. The Engineer shall have the right to witness testing conducted by the Contractor; provided, that the Contractor 's schedule is not delayed for the convenience of the Engineer.

C. In addition to those tests specifically required, the Engineer may request additional samples of any material including lining and coating samples for testing by the Owner. The additional samples shall be furnished as a part of the Work.

D. Inspection: Pipe shall be subject to inspection at the place of manufacture in accordance with the provisions of the referenced standards, as supplemented by the requirements herein. The Contractor shall notify the Engineer in writing of the manufacturing starting date not less than 14 Days prior to the start of any phase of the pipe manufacture.

E. During the manufacture of the pipe, the Engineer shall be given access to areas where manufacturing is in process and shall be permitted to make inspections necessary to confirm compliance with the Specifications.

PART 2 -- PRODUCTS

2.1 PIPE GENERAL

A. Mortar-lined ductile iron pipe shall conform to AWWA C151, C104, and C105, subject to the supplemental requirements in this Section. The pipe shall be of the diameter and class indicated, shall be provided complete with rubber gaskets, specials, and fittings as required under the Contract Documents.

B. Markings: The Contractor shall legibly mark specials 24-inches diameter and larger in accordance with the laying schedule and marking diagram. Each fitting shall be marked at each end with top field centerline.

C. Handling and Storage: The pipe shall be handled as a minimum at the 1/3 points by use of wide slings, padded cradles, or other devices designed and constructed to prevent damage to the pipe coating/exterior. The use of chains, hooks, or other equipment that might injure the pipe coating/exterior will not be permitted. Stockpiled pipe shall be supported on padded skids, sand or earth berms free of rock exceeding 3-inches diameter, sand bags, or suitable means so that the coating will not be damaged. The pipe shall not be rolled and shall be secured to prevent accidental rolling

D. Laying Lengths: Nominal pipe laying lengths shall be 20-feet.

E. Finish: The pipe shall have smooth dense interior surfaces and shall be free from fractures, excessive interior surface crazing, and roughness.

F. Closures and Correction Pieces: Closures and correction pieces shall be provided as required so that closures may be made due to different headings in the pipe laying operation and so that correction may be made to adjust the pipe laying to conform to pipe stationing on the Drawings. The locations of correction pieces and closure assemblies are indicated. Any change in location or number of said items shall only be as accepted by the Engineer.

2.2 SPECIALS AND FITTINGS

A. Fittings for ductile iron pipe shall conform to the requirements of AWWA C153 or AWWA C110 and shall have a minimum pressure rating of 250 psi. Ductile iron fittings larger than 48-inches shall conform to AWWA C153.

2.3 DESIGN OF PIPE

A. The pipe shall be designed, manufactured, tested, inspected, and marked according to AWWA C150 and C 151 except where modified by this Section.

B. Pipe Dimensions: The pipe shall be of the diameter and minimum Class 50.

C. Fitting Dimensions: The fittings shall be Class 50 and of the diameter indicated.

D. Joint Design: Ductile iron pipe and fittings for buried pressure service shall be furnished with restrained joints, unless otherwise indicated. Ductile iron pipe and fittings for buried gravity service shall be furnished with mechanical joints or push-on joints as required, unless otherwise indicated. Above ground ductile iron pipe and fittings joints shall be as indicated. Flanged joints or grooved and shouldered joints shall be furnished where required.

1. Mechanical and push-on joints shall conform to AWWA C111.

2. Flanged joints shall conform to AWWA C115. Where threaded flanges are provided, the pipe wall thickness under the cut threads shall not be less than the calculated net thickness required for the pressure class of the pipe.

3. Restrained joints at pipe-to-pipe locations shall be **Flex-Ring or Lok-Ring** restrained joint by **American Ductile Iron Pipe**, **TR FLEX** restrained joint by **U.S. Pipe**, or equal.

4. Restrained joints at pipe-to-fitting locations shall be **MegaLug Model 1100** as manufactured by **EBAA Iron** or equal.

E. For bell-and-spigot ends with rubber gaskets, the clearance between the bells and spigots shall be such that when combined with the gasket groove configuration and the gasket itself, will provide watertight joints under all operating conditions when properly installed. The Contractor shall require the pipe manufacturer to submit details complete with significant dimensions and tolerances and also to submit performance data indicating that the proposed joint has performed satisfactorily under similar conditions. In the absence of a history of field performance, the results of a test program shall be submitted.

2.4 CEMENT-MORTAR LINING

A. Cement-Mortar Lining for Shop Application: Except as otherwise provided herein, interior surfaces of ductile iron pipe, fittings, and specials shall be cleaned and lined in the shop with cement-mortar lining applied centrifugally in conformity with AWWA C104. During the lining operation and thereafter, the pipe shall be maintained in a round condition by suitable bracing or strutting. The lining machines shall be of a type that has been used successfully for similar work. Every precaution shall be taken to prevent damage to the lining. If lining is damaged or found defective at the Site, the damaged or unsatisfactory portions shall be replaced with lining conforming to these Specifications.

1. Cement: Cement for mortar lining shall conform to the requirements of AWWA C104; provided, that cement for mortar lining shall be Type II or V. Cement shall not originate from kilns that burn metal-rich hazardous waste fuel, nor shall a fly ash or pozzolan be used as a cement replacement.

B. The minimum lining thickness shall be as follows:

Nominal Pipe Diameter, inches	Minimum Lining Thickness, inches
3 - 12	1/16
14 - 24	3/32

C. Protection of Pipe Lining/Interior**:** Shop-applied cement mortar lining shall be given a seal coat of asphaltic material in conformance with AWWA C104.

2.5 EXTERIOR PROTECTION OF PIPE

A. Exterior Coating of Exposed Piping: The exterior surfaces of pipe which will be exposed to the atmosphere inside structures or above ground shall be thoroughly cleaned, given a shop coat of rust-inhibitive primer, and finish coated conforming to the requirements of Section 09 96 00 - Protective Coating.

B. Exterior Coating of Buried Piping: The exterior coating shall be an asphaltic coating approximately 1-mil thick.

PART 3 -- EXECUTION

3.1 INSTALLATION OF PIPE

A. The Contractor shall inspect each pipe and fitting prior to installation to insure that there are no damaged portions of the pipe. Pipe damaged prior to Substantial Completion shall be repaired or replaced by the Contractor.

B. Before placement of pipe in the trench, each pipe or fitting shall be thoroughly cleaned of any foreign substance which may have collected thereon and shall be kept clean at all

times thereafter. For this purpose, the openings of pipes and fittings in the trench shall be closed during any interruption to the Work.

C. Pipe Laying: The pipe shall be installed in accordance with AWWA C600.

D. Pipe shall be laid directly on the bedding material. No blocking will be permitted, and the bedding shall be such that it forms a continuous, solid bearing for the full length of the pipe. Excavations shall be made as needed to facilitate removal of handling devices after the pipe is laid. Bell holes shall be formed at the ends of the pipe to prevent point loading at the bells or couplings. Excavation shall be made as needed outside the normal trench section at field joints to permit adequate access to the joints for field connection operations and for application of coating on field joints.

E. Each section of pipe 24-inches diameter and larger shall be laid in the order and position shown on the laying schedule. Each section shall be laid to the line and grade, within approximately one-inch plus or minus.

F. Where necessary to raise or lower the pipe due to unforeseen obstructions or other causes, the Engineer may change the alignment and/or the grades. Such change shall be made by the deflection of joints, by the use of bevel adapters, or by the use of additional fittings. However, in no case shall the deflection in the joint exceed 75 percent of the maximum deflection recommended by the pipe manufacturer. No joint shall be misfit any amount that will be detrimental to the strength and water tightness of the finished joint.

G. Except for short runs that may be permitted by the Engineer, pipes shall be laid uphill on grades exceeding 10 percent. Pipe that is laid on a downhill grade shall be blocked and held in place until sufficient support is furnished by the following pipe to prevent movement. Bends shall be properly installed as indicated.

H. Cold Weather Protection: No pipe shall be installed upon a foundation into which frost has penetrated or at any time that there is a danger of the formation of ice or penetration of frost at the bottom of the excavation before backfilling occurs.

I. Pipe and Specials Protection: The openings of pipe and specials shall be protected with suitable bulkheads to prevent unauthorized access by persons, animals, water, or any undesirable substance. At all times, means shall be provided to prevent the pipe from floating.

J. Pipe Cleanup: As pipe laying progresses, the Contractor shall keep the pipe interior free of debris. The Contractor shall completely clean the interior of the pipe of sand, dirt, mortar splatter, and any other debris following completion of pipe laying and shall perform any necessary interior repairs prior to testing and disinfecting the completed pipeline.

3.2 RUBBER GASKETED JOINTS

A. Rubber Gasketed Joints: Immediately before jointing pipe, the bell end of the pipe shall be thoroughly cleaned, and a clean rubber gasket shall be placed in the bell groove. The spigot end of the pipe and the inside surface of the gasket shall be carefully cleaned and lubricated. The lubricant shall be suitable for lubricating the parts of the joint for assembly and be a compound listed as in compliance with NSF Standard 61. The lubricant shall be nontoxic, shall not support the growth of bacteria, and shall have no deleterious effects on the gasket material. The lubricant shall not impart taste or odor to water in the pipe. The

spigot end of the pipe section shall then be inserted into the bell of the previously laid joint and telescoped into its proper position. Tilting of the pipe to insert the spigot into the bell will not be permitted.

3.3 INSTALLATION OF PIPE APPURTENANCES

A. Protection of Appurtenances: Where the joining pipe is dielectric-coated, buried appurtenances shall be coated in kind. Where pipe is encased in polyethylene sleeves, buried appurtenances shall be encased in polyethylene.

B. Installation of Valves: Valves shall be handled in a manner to prevent any injury or damage to any part of the valve. Joints shall be thoroughly cleaned and prepared prior to installation. The Contractor shall adjust stem packing and operate each valve prior to installation to insure proper operation.

C. Valves shall be installed so that the valve stems are plumb and in the location indicated.

END OF SECTION

SECTION 33 95 33 - CORRUGATED POLYETHYLENE PIPE (PROFILE WALL PIPE)

(ASTM F2306 & F2648, MODIFIED)

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall provide smooth interior, corrugated high density polyethylene (HDPE) pipe, and fittings, complete and in place, in accordance with the Contract Documents.

B. A single pipe manufacturer shall be made responsible for furnishing smooth interior, corrugated (profile wall) polyethylene pipe, fittings, and appurtenances for the work.

1.2 REFERENCES SPECIFICATIONS, CODES, AND STANDARDS

1. ASTM F 2306 - Standard Specification for 12 to 60 in. Annular Corrugated Profile-Wall Polyethylene (PE) Pipe and Fittings for Gravity-Flow Storm Sewer and Subsurface Drainage Applications

2. ASTM F 2648 - Standard Specification for 2 to 60 inch [50 to 1500 mm] Annular Corrugated Profile Wall Polyethylene (PE) Pipe and Fittings for Land Drainage Applications

3. ASTM D 3213 - Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals

4. ASTM F 714 - Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter

5. ASTM D 3350 - Standard Specification for Polyethylene Plastics Pipe and Fittings Materials

6. ASTM D 2412 - Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading

7. ASTM D 2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications

8. ASTM F 477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

9. AASHTO National Transportation Product Evaluation Program (NTPEP) 3rd Party Certification program.

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals.

B. Product Information: Furnish product information for pipe, fittings, and appurtenances showing compliance with requirements of this section.

1.4 QUALITY ASSURANCE

A. Each manufacturer shall have an approved in-house QA/QC program for compliance to the testing specifications and requirements

PART 2 - PRODUCTS

2.1 GENERAL

A. High Density Polyethylene (HDPE) Corrugated and Smooth Lined Pipe & Fittings 12” to 60” in diameter shall be manufactured in accordance with requirements of ASTM F 2306, latest edition. Type S: This pipe shall have a full circular cross section, with an outer corrugated pipe wall and a smooth inner wall.

B. High Density Polyethylene (HDPE) Corrugated and Smooth Lined Pipe & Fittings 4” to 10” in diameter shall be manufactured in accordance with requirements of ASTM F 2648, latest edition.

C. High Density Polyethylene (HDPE) Corrugated and Smooth Lined Pipe shall be manufactured from virgin PE compounds which conform with the requirements of cell class 435400C as defined and described in ASTM D 3350.

D. Minimum Pipe Stiffness (PS) at five percent deflection shall be as described in ASTM F 2306 when tested in accordance with ASTM D 2412.

E. Perforated Pipe:

1. Where shown, pipe shall be perforated. Perforations shall be pre-cut by the pipe manufacturer at the factory prior to delivery.

2. Slotted drain pipe shall be corrugated, slotted polyethylene pipe conforming to this specification.

3. The pipe shall have a minimum of three rows or slots, with each row 120 degrees apart. Slots shall be between 0.05- and 0.1-inch wide and between 1.0- and 15-inches long, arranged circumferentially around the pipe. The pipe shall have approximately 20 slots per foot. Slots shall be smooth, clean, and clear of plastic debris.

F. Joints: Joints for buried pipe shall be an integral bell and spigot in accordance with *ASTM F2306 for 12” to 60” diameter pipe and ASTM F2648 for 4” to 10” diameter pipe*.

G. Markings: The manufacturer shall legibly mark pipe, specials, and fittings in accordance with the laying schedule and marking diagram. Each pipe and fitting shall be numbered in sequence and said number shall appear on the laying schedule and marking diagram in its proper location for installation. Each pipe, fitting, and special shall be marked at each end with top field centerline.

H. Handling and Storage: The pipeand fittings shall be handled by use of wide slings, padded cradles, or other devices/methods to prevent damage to the pipe. The use of chains, hooks, or other equipment that might injure the pipe will not be permitted. Stockpiled pipe, specials, and fittings shall be supported on padded skids, sand or earth berms free of rock exceeding 3-inches diameter, sand bags, or suitable means so that the pipe will not be damaged. Pipe, specials, and fittings shall not be rolled and shall be secured to prevent accidental rolling.

I. The Contractor shall replace or repair damaged pipe and fittings.

J. Strutting: Adequate strutting shall be provided on fittings, and straight pipe so as to avoid damage to the pipe and fittings during handling, storage, hauling, and installation.

K. Laying Lengths: Maximum pipe laying lengths shall be 48-ft with shorter lengths provided as required.

L. Closures and Correction Pieces: Closures and correction pieces shall be provided as required so that closures may be made due to different headings in the pipe laying operation and so that correction may be made to adjust the pipe laying to conform to pipe stationing indicated.

M. Couplings: shall be installed as recommended by the coupling manufacturer. All couplings shall receive manufacturer's prime coat and corrosion-resistant finish coat

1. Flexible type couplings, where indicated on the Drawings, shall be:

a. **Dresser Style 40**, or **Romac** equivalent, for nominal diameters smaller than 18”

b. **Dresser Style 38**, or **Romac** equivalent with:

1) Middle ring length for pipe 18 inches to 36 inches nominal diameter shall be 16 inches.

2) Middle ring length for pipe 42 inches in diameter or greater shall be 18 inches

2. Flange to pipe coupling adapters may be **Rockwell Type 913**. The coupling-rated working pressure shall be not less than the service rating of the pipeline. The middle ring shall have a minimum thickness of 3/8 inch, and the follower ring shall have a minimum thickness of 1/4 inch. Coupling gaskets shall be supplied by the coupling manufacturer.

3. Victaulic couplings will be standard coupling **Style 77**, malleable iron housing, with factory standard, orange enamel housing coating. Gaskets shall be Grade T Buna N with temperature range from minus 20° F to plus 180° F. Bolts and nuts shall be heat-treated carbon steel conforming to *ASTM A183*. Grooves on pipes fitted with **Victaulic** couplings shall have factory recommended groove cuts suitable for **Style 77** couplings.

N. Flexible Pipe-to-Manhole or Catchbasin Connector: Use **KOR-N-SEAL** connectors with stainless steel fastening hardware, manufacturer: **NPC Inc.** or Engineer-approved equal.

2.2 FITTINGS

A. Fittings shall conform to the requirements of ASTM F2306 for 12” to 60” diameter pipe and ASTM F2648 for 4” to 10” diameter pipe.

B. Metal fittings shall be lined and coated in accordance with the requirements of Section 09800 Protective Coating.

C. Each fitting shall be clearly labeled to identify its size and stiffness class.

D. Fittings shall be smooth inside and free from any obstructions to flow.

E. Caps: Where shown, provide caps at open ends of pipe. Provide caps which permanently prevent intrusion of soil into the pipe. Provide caps per manufacturer’s recommendations.

2.3 TRACER WIRE AND WARNING TAPE

A. The entire length of all polyethylene pipe runs shall contain a 12-gauge, direct-bury, UF, single-conductor tracer wire, and a warning tape at 6-inches directly above non-metallic pipe. The tracer wire shall be accessed by 1-inch PVC pipe stubbed out of the ground complete with cap and identifying label. The PVC stubs shall be located as shown on the Drawings.

B. The pipeline shall be marked with a magnetically detectable marking tape. The tape shall be placed along the trench centerline between 18- and 24-inches above the pipe.

PART 3 - EXECUTION

3.1 GENERAL

A. Laying, jointing, testing for defects and for leakage shall be performed in the presence of the Contracting Officer, and shall be subject to approval before acceptance. Material found to have defects will be rejected and the Contractor shall promptly remove such defective materials from the site.

B. Welded fittings shall be free from internal flow obstructions, including but not limited to beading from welds. All pipe and fittings found to have any internal obstruction to flow shall be rejected by the Contractor upon delivery to the site.

C. Installation shall conform to the requirements of *ASTM F2306, ASTM F2648, and ASTM D2321*, instructions furnished by the pipe manufacturer, and to the supplementary requirements herein. Wherever the provisions of this section and the aforementioned requirements are in conflict, the more stringent provision shall apply.

D. No vehicular traffic of any kind shall be parked, driven, loaded, unloaded, or in any way located on top of PE drainage pipe without a minimum nominal continuous cover of 24” of rock or soil above the top of the pipe.

3.2 INSTALLATION OF PIPE

A. Handling and Storage

1. Pipe, specials, and fittings shall be carefully handled and protected against damage to interior and exterior surfaces, and impact shocks and free fall. Pipe, specials, and fittings shall not be placed directly on rough ground but shall be supported in a manner that will protect the pipe against injury whenever stored at the site or elsewhere. Pipe, specials, and fittings shall be handled and stored at the site in accordance with the requirements stated in Part 2, above. No pipe shall be installed when the interior or exterior surfaces show damage that may be harmful as determined by the Engineer. Such damaged interior and exterior surfaces shall be repaired or a new undamaged pipe, special, or fitting shall be provided.

2. Under no circumstances shall pipe, fittings or any other material be dropped or dumped into trenches.

3. Pipe should be stored, if possible, at the site in unit packages provided by the manufacturer. Caution should be exercised to avoid compression damage or deformation to bell ends of the pipe. Pipe should be stored in such a way as to prevent sagging or bending and be protected from exposure to direct sunlight by covering with an opaque material while permitting adequate air circulation above and around the pipe. Gaskets should be stored in a cool, dark place out of the direct rays of the sun, preferably in original cartons.

B. Pipe damaged prior to Substantial Completion shall be repaired or replaced.

C. The Contractor shall inspect each pipe, special, and fitting for damage. The Contractor shall remove or smooth out any burrs, gouges, weld splatter, or other small defects prior to laying the pipe, special, or fitting.

D. Before placement of pipe or fittings in the trench, each shall be thoroughly cleaned of any foreign substance that may have collected thereon and shall be kept clean thereafter. For this purpose, the openings of pipes, specials, and fittings in the trench shall be closed during any interruption to the work.

E. Pipe and fittings shall be laid directly on the imported bedding material. No blocking will be permitted, and the bedding shall be such that it forms a continuous, solid bearing for the full length of the pipe, special, or fitting. Excavations shall be made as needed to facilitate removal of handling devices after the item is laid. Bell holes shall be formed at the ends of the pipe to prevent point loading at the bells or couplings. Excavation outside the normal trench section shall be made at field joints as needed to permit adequate access to the joints for field connection operations and for application of coating on field joints.

3.3 TRENCHING AND BACKFILL

A. Trench excavation and backfill shall conform to Section 31 30 00 - Earthwork.

B. Bell-and-spigot pipe shall be laid with the bell end pointing in the direction of laying. Pipe shall be graded in straight lines, taking care to avoid the formation of any dips or low points. Pipe shall not be laid when the conditions of trench or weather are unsuitable. At the end of each day's work, open ends of pipe shall be closed temporarily with wood blocks or bulkheads.

C. Perforated Pipe: Perforated pipe shall be installed with perforations on the bottom side of the pipe, oriented symmetrically with respect to a vertical line through the center of the pipe.

D. Installation Tolerances: Each section of pipe or fitting shall be laid in the order and position on the laying diagram and in accordance with the following:

1. Each section of pipe or fitting having a nominal diameter less than 48-inches shall be laid to line and grade, within plus or minus 2-inches horizontal deviation and plus or minus 1-inch vertical deviation.

2. In addition to the horizontal and vertical tolerances above, lay the pipe so that no high or low points other than those on the laying diagram are introduced.

3. After installation, pipeand fittings shall not show deflection greater than 2.25 percent for mortar-lined and flexible-coated pipe, specials, and fittings; and 3.0 percent for flexible-lined and flexible-coated or bare pipe, specials, and fittings. The allowable deflection shall be based on the design inside diameter.

E. Pipe shall be cut by means of saws, power driven abrasive wheels, or pipe cutters, which will produce a square cut. No wedge-type roller cutters will be permitted. After cutting, the end of the pipe shall be beveled using a beveling tool, portable type sander, or abrasive disc.

F. Trenches shall be kept free of water until joints have been properly made.

G. Joints: Joints shall be installed such that the connection of pipe sections will form a continuous line free from irregularities in the flow line. All installations shall require watertight joints that meet a 10.8 psi laboratory test per ASTM D3212 and utilize a bell and spigot design with a gasket meeting ASTM F477.

H. Pipe crossings with less than 6” of vertical separation requires a layer of Polyethylene plastic foam (Ethafoam) between the pipes. The Ethafoam underground utility separation must comply with the Federal Specification Cid A-A 59136 Type 1, Class 1, Grade A.

I. Solid wall pipe installations below asphalt with less than 12” of cover requires trench backfill with Controlled Density Fill (CDF)/Controlled Low-Strength Material (CLSM), see WSDOT 6-02.3(5)C. Pipe floatation during the CDF curing period must be prevented.

END OF SECTION

SECTION 33 95 34 – LARGE POLYETHYLENE PRESSURE PIPING

PART 1 -- GENERAL

1.1 SECTION INCLUDES

A. The Contractor shall provide high density polyethylene (HDPE) pressure pipe, complete and in place, in accordance with the Contract Documents.

B. Following joining, Contractor shall grind or remove any material from the pipe interior to provide smooth surfaces for fish and water transfer for all pipes that may come in contact with fish.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

AWWA C906	Polyethylene (PE) Pressure Pipe and Fittings, 4-In Through 63-In, for Water Distribution and Transmission
ASTM D 3350	Polyethylene Plastics Pipe and Fittings Materials

1.3 CONTRACTOR SUBMITTALS

A. Furnish Shop Drawings of pipe, fittings, and appurtenances in accordance with Section 01 33 00 - Contractor Submittals.

B. Certifications: Furnish a certified affidavit of compliance for pipe and other products or materials furnished under this Section:

1. Hydrostatic proof test reports.

2. Sustained pressure test reports.

3. Burst strength test reports.

C. Expenses incurred in making samples for certification of tests shall be borne by the Contractor as part of the Work.

1.4 QUALITY ASSURANCE

A. Each manufacturer shall have an approved in-house QA/QC program for compliance to the testing specifications and requirements of AWWA C906 for both pipe and fittings.

B. Inspection: Pipe shall be subject to inspection at the place of manufacture in accordance with the provisions of the referenced standards as supplemented by the requirements herein. The Contractor shall notify the Engineer in writing of the manufacturing start date not less than 14 calendar days prior to the start of any phase of manufacture.

C. During manufacture of the pipe, the Engineer shall be given access to areas where manufacturing is in process confirm compliance with the Specifications.

D. Factory Acceptance Tests: Except as modified herein, materials used in the manufacture of the pipe shall be tested in accordance with the requirements of this Section and in the referenced standards, as applicable.

E. The Contractor shall perform said material tests in accordance with the requirements of the Contract Documents. The Engineer shall have the right to witness testing conducted by the Contractor, provided that the Contractor's schedule will not be delayed for the convenience of the Engineer.

F. In addition to those tests specifically required, the Engineer may request additional samples of any material for testing by the Owner. The additional samples shall be furnished as part of the Work.

G. Installation: Contractor shall be trained and certified by the manufacturer prior to installing HDPE pipe.

H. Inspection: Pipe shall be subject to inspection at the place of manufacture in accordance with the provisions of ASTM F 2306, F 2648, D 3212, and F 714 as supplemented by the requirements herein. The Contractor shall notify the Engineer in writing of the manufacturing start date not less than 14 days prior to the start of any phase of the pipe manufacture.

I. Site Acceptance Testing: Following installation, pipe shall be tested in accordance with ASTM F2487 Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Corrugated High Density Polyethylene Pipelines or ASTM F1417 Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Scope: The pipe shall be 54-, 24-, 18-, or 12, 8, 6, or 4- inch nominal, as indicated in the plans, meeting the specifications and requirements of AWWA C 906. Pipe shall be in steel pipe sizes (IPS). Pipe shall be in ductile iron pipe sizes (DIPS).

B. Materials: Pipe and fittings shall be made from prime virgin resins exhibiting a cell classification of PE 345444C as defined in ASTM D 3350, with an established hydrostatic-design basis of 1600 psi for water at 73 degrees F. The resin shall be listed by the PPI (Plastic Pipe Institute) in its pipe-grade registry Technical Report (TR) 4, "Listing of Plastic Pipe Compounds.

C. Pipe and Fittings: The pressure rating shall be at least DR 17. Laying lengths shall be 20-ft standard. Both pipe and fittings shall be listed as compliant with NSF Standard 61 and shall bear the "NSF-pw" logo or mark.

D. Joints and Fittings: Pipe sections shall be joined by heat fusion, but mechanical joint fittings may be used in circumstances where heat fusion is not practical

E. Marking: Pipe and fittings shall be marked as prescribed by AWWA C906. Pipe markings shall include nominal size, OD base (ie: 12-inch ductile iron pipe sizing,

DIPS), dimension ratio, pressure class, AWWA C906, manufacturer's name, manufacturer's production code including day, month, and year extruded, manufacturer's plant and extrusion line, and the “NSF-pw” logo.

F. Couplings: shall be installed as recommended by the coupling manufacturer. All couplings shall receive manufacturer's prime coat and corrosion-resistant finish coat

1. Flexible type couplings, where indicated on the Drawings, shall be:

G. Dresser Style 40, or Romac equivalent, for nominal diameters smaller than 18”

H. Dresser Style 38, or Romac equivalent with:

a. Middle ring length for pipe 18 inches to 36 inches nominal diameter shall be 16 inches.

b. Middle ring length for pipe 42 inches in diameter or greater shall be 18 inches

I. Flange to pipe coupling adapters may be Rockwell Type 913 or Romac equivalent. The coupling-rated working pressure shall be not less than the service rating of the pipeline. The middle ring shall have a minimum thickness of 3/8 inch, and the follower ring shall have a minimum thickness of 1/4 inch. Coupling gaskets shall be supplied by the coupling manufacturer.

J. Victaulic couplings will be standard coupling Style 77, malleable iron housing, with factory standard, orange enamel housing coating. Gaskets shall be Grade T Buna N with temperature range from minus 20° F to plus 180° F. Bolts and nuts shall be heat-treated carbon steel conforming to ASTM A183. Grooves on pipes fitted with Victaulic couplings shall have factory recommended groove cuts suitable for Style 77 couplings.

2.2 TRACER WIRE AND PLASTIC WARNING TAPE

A. The pipeline shall be marked with a magnetically detectable marking tape. The tape shall be placed along the trench centerline between 18- and 24-inches above the pipe.

B. The entire length of all polyethylene pipe runs shall contain a 12-gauge, direct-bury, UF, single-conductor tracer wire, and a warning tape at 6-inches directly above non-metallic pipe. The tracer wire shall be accessed by 1-inch PVC pipe stubbed out of the ground complete with cap and identifying label. The PVC stubs shall be located as shown on the Drawings.

PART 3 -- EXECUTION

3.1 GENERAL

A. Laying, jointing, and testing for defects and for leakage shall be performed in the presence of the Engineer and shall be subject to approval before acceptance. All

material found to be defective will be rejected and the Contractor shall promptly remove such materials from the Site.

B. Installation shall conform to AWWA M23, instructions furnished by the pipe manufacturer, and to the supplementary requirements or modifications herein. Wherever the provisions of this Section and the aforementioned requirements are in conflict, the more stringent provision shall apply.

3.2 HANDLING AND STORAGE

A. Handling: Pipe, fittings, and accessories shall be carefully inspected before and after installation and those found defective will be rejected. Pipe and fittings shall be free from fins and burrs. Before placing in position, clean pipe, fittings, and accessories, and maintain them in a clean condition. Proper methods shall be used for lowering sections of pipe into trenches. Under no circumstances shall pipe, fittings, or any other material be dropped or dumped into trenches.

B. Storage: Pipe shall be stored, if possible, at the Site in unit packages provided by the manufacturer. Caution should be exercised to avoid compression damage or deformation to the pipe. Pipe shall be stored in such a way as to prevent sagging or bending, and it shall be protected from exposure to direct sunlight by covering with an opaque material that allows adequate air circulation above and around the pipe. Gaskets shall be stored in a cool, dark place out of the direct rays of the sun, preferably in original cartons.

3.3 TRENCHING AND BACKFILL

A. Trench excavation and backfill shall conform to Section 31 30 00 - Earthwork.

3.4 JOINING

A. Prior to installation of any pipe, the manufacturer shall provide training in the recommended butt fusion and saddle fusion procedures, testing procedures, and any other installation methods required by the Work. Training shall include the Contractor's installation personnel, an Owner's representative, the Engineer's representative, and any other personnel chosen by the Owner. The Contractor shall record the names of trained personnel.

B. Butt Fusion

1. The pipe shall be joined by the butt fusion procedure outlined in ASTM F 2620. All fusion joints shall be made in compliance with the pipe or fitting manufacturer's recommendations. Fusion joints shall be made by qualified fusion technicians.

2. On every day that butt fusion joints are to be made, the first fusion of the day shall be a test. The test fusion shall be allowed to cool completely, then fusion test straps shall be cut out. Test strap length shall be 12-inches (min) or 30 times the wall thickness with the fused area in the center and width shall be 1-inch (min) or 1.5 times the wall thickness. The Contractor shall bend the test strap until the ends of the strap touch. If the test strap fails at the joint, the Contractor shall perform a new test to be cooled completely and bent as before.

The Contractor shall not commence installation of pipe until a test fusion has passed the bent strap test.

C. Saddle Fusion: Saddle fusion, where necessary, shall be done in accordance with ASTM F 2620 and the fitting manufacturer's recommendations. Saddle fusion joints shall be made by qualified fusion technicians. Qualification of the fusion technician shall be demonstrated by evidence of fusion training within the past year on the equipment to be utilized on this project.

D. Following joining, all joints shall have a smooth interior without offsets, depressions or protrusions. Contractor shall grind or remove any material from the pipe interior to provide smooth surfaces for fish and water transfer.

3.5 INSTALLATION

A. Trench shall be graded in straight or curved lines matching the proposed alignments, taking care to avoid formation of any dips or low points. Pipe shall not be laid when the conditions of trench or weather are unsuitable. At the end of each day's work, open ends of pipe shall be closed temporarily with wood blocks or bulkheads.

B. Pipe shall be cut by means of saws, power driven abrasive wheels, pipe cutters, or other manufacturer recommended methods that will produce a clean, square cut.

C. Pipe shall be supported uniformly and firmly at its proper elevation. Wood support blocking will not be permitted. The full length of each section of pipe and fittings shall rest solidly on the soil, with recesses to accommodate joints and couplings. Anchors and supports shall be provided where necessary and where indicated for fastening Work into place. Fittings shall be independently supported.

D. Short lengths of pipe shall be used in and out of each rigid joint or rigid structure. Piping that does not allow sufficient space for proper installation of jointing shall be replaced.

E. Joints shall be installed according to manufacturer's recommendations. Trenches shall be kept free of water until joints have been properly made. The maximum combined deflection at any coupling shall be in accordance with the manufacturer's recommendations.

F. Pipe crossings with less than 6" of vertical separation requires a layer of Polyethylene plastic foam (Ethafoam) between the pipes. The Ethafoam underground utility separation must comply with the Federal Specification Cid A-A 59136 Type 1, Class 1, Grade A.

G. Pipe installations below grade with less than 12" of cover requires trench backfill with Controlled Density Fill (CDF)/Controlled Low-Strength Material (CLSM), see WSDOT 6-02.3(5)C. Pipe floatation during the CDF curing period must be prevented.

H. The Contractor shall maintain installed piping with a minimum of 3ft of burial depth before driving heavy construction equipment over the pipe.

3.6 FIELD TESTING

A. Field testing shall conform to the requirements of Section 01 74 30 - Pressure Pipe Testing.

END OF SECTION

SECTION 40 05 00 - PIPING, GENERAL

GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide piping systems indicated, complete and operable, in accordance with the Contract Documents.

B. The provisions of this Section shall apply to piping in Divisions 33 and 40, and on the Drawings and as indicated in the Piping Schedule.

C. The Drawings define the general layout, configuration, routing, method of support, pipe size, and pipe type. The Drawings are not pipe construction or fabrication drawings. The CONTRACTOR shall prepare pipe spooling and fabrication drawings and shall submit them to the ENGINEER for review.

D. Where pipe layout details are not indicated on the Drawings, it is the CONTRACTOR'S responsibility to develop the details necessary to design and construct piping systems to accommodate the specific equipment provided, and to provide spacers, fittings, adapters, and connectors for a complete and functional system.

E. Directional drilling shall not be used on this project. All HDPE pipe shall be laid in excavated trenches to the elevations shown on the drawings.

1.2 DEFINITIONS

A. Pipe, piping, pipe work, pipe system, piping system, or similar words, singular or plural shall mean and include, any type of pipes, tubes, fittings, valves, piping specialties, appurtenances, supports, restraints, anchors, coatings and linings and items related to piping.

B. Submerged piping, underwater piping or similar words, shall include any piping located up to two feet above water surface in basins or tanks

C. Potable water or similar words, shall mean and include any type of potable water or process water that be deemed potable after treatment processes.

D. Corrosive service shall mean and include in locations listed below:

a. Buried locations

b. Submerged locations or submerged piping.

c. Inside buried vaults, manholes, and structures that do not drain through a gravity sewer or to a sump with a pump.

d. Inside trenches, containment walls, and curbed areas

e. Locations indicated or designated in the contract documents.

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Contractor Submittals.

B. Shop Drawings: Shop Drawings shall contain the following information:

1. Drawings: Layout drawings including necessary dimensions, details, pipe joints, fittings, specials, bolts and nuts, gaskets, valves, appurtenances, anchors, guides, and material lists. Pipe spooling and fabrication drawings shall indicate spacers, adapters, connectors, fittings, and pipe supports to accommodate the equipment and valves in a complete and functional system.

2. Pipe Supports: Submit pipe support fabrication drawings including calculations in accordance with Section 40 05 07 - Pipe Supports.

3. Grooved joint couplings and fittings shall be shown on drawings and product submittals, and shall be specifically identified with the applicable style or series designation, and restraint system if applicable.

4. Thermoplastic Pipe Joints: For PVC and ABS piping, submit solvent cement manufacturer's catalog indicating that the recommended product is suitable for each fluid service application. For HDPE pipe submit pipe butt and fitting fusion procedure for field and factory joining methods.

5. Gasket Material: Submit gasket manufacturer's catalog indicating that the recommended product is suitable for each fluid service application.

6. Seals and Seating Materials: Submit elastomer material and manufacturer's catalog indicating that the recommended product is suitable for each fluid service application.

7. Modular Seals for Pipe: Manufacturer's catalog sheet showing materials and installation procedures.

C. Samples

1. Performing and paying for sampling and testing as necessary for certifications are the CONTRACTOR'S responsibility.

D. Certifications

1. Necessary certificates, test reports, and affidavits of compliance shall be obtained by the CONTRACTOR.

2. A certification from the pipe fabricator that each pipe will be manufactured subject to the fabricator’s or a recognized Quality Control Program. An outline of the program shall be submitted to the ENGINEER for review prior to the manufacture of any pipe.

1.4 MATERIAL DELIVERY, STORAGE, AND PROTECTION

A. Piping materials, fittings, valves, and accessories shall be delivered in a clean and undamaged condition and stored off the ground for protection against oxidation caused by ground contact.

B. Defective or damaged materials shall be marked as such, removed from the site, and replaced with new materials.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Extent of Work

1. Pipes, fittings, and appurtenances shall be provided in accordance with the requirements of the applicable Sections of Divisions 33 and 40 and as indicated.

2. Materials in contact with potable water or process water that be deemed potable after treatment processes shall be listed as compliant with NSF Standard 61.

B. Piping Supports

1. Pipes shall be adequately supported, restrained, and anchored in accordance with Section 40 05 07 – Pipe Supports, and as indicated.

2. Piping support seismic and wind loads shall be sized in accordance with the design criteria as shown on GS-1 – General Structural Notes– Design Criteria– Seismic Loads.

C. Lining

1. Application, thickness, and curing of pipe lining shall be in accordance with the applicable Sections of Division 33, unless otherwise indicated.

D. Coating

1. Application, thickness, and curing of coating on buried pipe shall be in accordance with the applicable Sections of Division 33 and Section 09 96 00 - Protective Coating, unless otherwise indicated.

2. Pipes above ground or in structures shall be coated in accordance with Section 09 96 00 – Protective Coating.

E. Pressure Rating

1. Piping systems shall be designed for the pressure as defined in respective pipe sections, or as indicated on the Piping Schedule, whichever is greater.

F. Inspection

1. Pipe shall be subject to inspection at the place of manufacture.

2. During the manufacture, the ENGINEER shall be given access to areas where manufacturing is in progress and shall be permitted to make inspections necessary to confirm compliance with requirements.

G. Tests

1. Except where otherwise indicated, materials used in the manufacture of the pipe shall be tested in accordance with the applicable specifications and standards.

2. The CONTRACTOR shall be responsible for performing material tests.

2.2 PIPE FLANGES

A. General

1. Flanges shall be provided with flat faces and shall be attached with bolt holes straddling the vertical axis of the pipe unless otherwise indicated.

2. Flange faces shall be perpendicular to the axis of the adjoining pipe.

3. Flanges for miscellaneous small diameter pipes shall be in accordance with the standards indicated for those pipes.

B. Pressure Ratings

1. 150 psig or less: Flanges shall conform to either AWWA C207 - Steel Pipe Flanges for Waterworks Service--Sizes 4 In. Through 144 In., Class D, or ASME B16.5 - Pipe Flanges and Flanged Fittings, Class 150.

2. Selection Based on Test Pressure

a. Do not expose AWWA flanges to test pressures greater than 125 percent of rated capacity.

C. Blind Flanges

1. Provide blind flanges in accordance with AWWA C207, or as indicated for miscellaneous small pipes.

2. Blind flanges for pipe diameters 12 inches and greater shall be provided with lifting eyes in the form of welded or threaded eye bolts.

D. Flange Coating

1. Machined faces of metal blind flanges and pipe flanges shall be coated with a temporary rust-inhibitive coating to protect the metal until the installation is completed.

E. Flange Fasteners

1. Unless otherwise shown on the drawings, or indicated in the applicable Sections of Divisions 33 and 40, Bolts and nuts shall conform to the following requirements;

a. Threads shall be in accordance with ANSI/ASME B1.1, Class 2, UNC for bolt diameters 1” and smaller and UN8 for bolt diameters greater than 1”.

b. Bolts shall have heavy hexagon heads and heavy hexagon nuts. Length of studs shall provide a projection of not less than 0.25 inch and no more than 0.5 inch through the nut when it is drawn tight.

c. Thread studs on flange connections are not permitted except where space restrictions preclude the use of standard bolts and where approved by the ENGINEER.

d. Through bolt holes shall be drilled in accordance with the applicable flange standard.

e. All bolts fastening metallic flanges shall be provided with plain washers installed under the nut. Washer materials shall be of the same material as the bolt. If the through bolt holes are drilled larger than the applicable standard by 1/8 inch in diameter or more, bolts shall be also installed with a plain washer under the bolt head as well.

f. All bolts fastening non-metallic flanges shall be provided with plain washers installed under both the bolt head and nut.

g. Washer materials shall be of the same material as the bolt.

h. Anti-seize compound shall be used on carbon steel fasteners, and shall be Husk-ITT, Husky 2000; or equal.

i. Anti-galling compound used for stainless steel fasteners in LOX, nitrogen injection, oxygen, ozone process/off-gas/vent and ozone contactor maintenance air service shall be DuPont “Krytox”; or equal.

j. Anti-galling compound used for stainless steel fasteners for other services shall be certified for potable water use and shall be Husk-ITT, Lube O’seal; Hercules, Real-Tuff; La Co, Slic-Tite; or equal.

2. Fastener Material Group Numbering System

a. Flange fasteners shall conform to the following material standards and shall be categorized within the Fastener Material Schedule Groups as indicated:

1) Material Group C1 (Carbon steel): ASTM A307 Grade B bolts, ASTM A563 Grade B nuts with ASTM F436 washers

2) Material Group C2 (Carbon steel): ASTM A193 Grade B7 bolts, ASTM A194 Grade 2H nuts with ASTM F436 washers

3) Material Group S1 (316 SS): ASTM A193, Grade B8M bolts, ASTM A194 Grade 8M nuts with Type 316 SS plain washers.

4) Material Group S2 (304 SS): ASTM A193, Grade B8 bolts, ASTM A194 Grade 8F nuts with Type 304 SS plain washers.

5) Material Group S3 (Hastelloy C-276): ASTM F468 N10276 bolts ASTM F467 N10276 nuts with type Hastelloy plain washers.

3. Fastener Material Group Numbers used in Non-Corrosive Service Applications

a. AWWA C115 ductile iron flanges - Material Group C1

b. AWWA C207 steel flanges - Material Group C2

c. ASME B31 group piping flanges – Material Group C2

d. Non-metallic pipe flanges - Material Group S1

e. Stainless steel pipe flanges and all others not listed above - Material Group S1

f. Where mating flanges are of different flange material standards and the specified Fastener Material Groups are in conflict, then fasteners of the higher grade shall be utilized unless otherwise indicated. For the purpose of this requirement, the Material Groups in order of decreasing grade shall be S1, C2, C1. Provide insulating flange sets for dissimilar metal flanged piping to electrically isolate the dissimilar piping.

g. Where gaskets of Teflon or Viton-A are required, fasteners of Material Group C2 shall be utilized for all C1 flange standards.

4. Fastener Material Group Numbers used in Corrosive Service Applications

a. All Flange fasteners shall be of Material Group S1 unless S2 and S3 are otherwise indicated on the drawings.

F. Insulating Flanges

1. Insulated flanges shall be provided with bolt holes 1/4-inch diameter greater than the bolt diameter.

G. Insulating Flange Sets

1. In order to prevent corrosion, insulating flange sets shall be furnished on all piping connections where two dissimilar metals are to be connected. Each insulating flange set shall consist of an insulating gasket, insulating sleeves and washers, and a steel washer.

2. For bolt diameters 1-1/2 inches or smaller, insulating sleeves and washers shall be one piece and shall be made of acetyl resin.

3. For bolt diameters larger than 1-1/2 inches, insulating sleeves and washers shall be 2-piece and shall be made of polyethylene or phenolic material.

4. Insulating flange sets materials used for fluids other than general water and wastewater shall be made of materials compatible with the fluid services.

5. Insulating gaskets shall be full-face.

H. Insulating Flange Manufacturer, or Equal

1. **JM Red Devil, Type E**

2. **Fluid Sealing Products, Inc.**

3. **Enpro Industries, Inc. (GPT)**

I. Flange Gaskets

1. Gaskets for flanged joints used in general water and wastewater service shall be full faced type in accordance with AWWA C207, suitable for temperatures to 700 degrees F, a pH of one to 11, and pressures to 1000 psig.

2. Blind flanges shall be provided with gaskets covering the entire inside face of the blind flange and shall be cemented to the blind flange.

3. Ring gaskets will not be accepted unless otherwise indicated.

4. Unless otherwise indicated, flange gaskets up to 150 psi shall be EPDM sheet material, NSF 61 approved, **Garlock, Style 98206-U (unbranded), or similar products from John Crane, or equal**.

5. Gaskets for flanged joints used in cryogenic oxygen (LOX and GOX) service shall be Teflon material, **Garlock Gylon, Style 3502 and 3503 or similar products from John Crane, or equal**.

6. Gaskets for flanged joints in PVC and CPVC piping used in general water and wastewater service shall be NSF 61 approved, full-faced, 1/8-inch thick, and made of fluoroelastomer having a durometer hardness of 50 to 70. Gaskets for pipe sizes up to 24-inch and 150 psi shall be Garlock Style XP or similar products from John Crane, or equal.

7. When the mating flange has a raised face, provide stainless steel flat ring gasket filler between the PVC flange and gasket and the adjacent flange.

8. Gaskets for flanged joints used in chemicals, hot air, ozone gas, solvents, hydrocarbons, steam, chlorine and other fluids shall be made of materials compatible with the service, pressure, and temperature. Consult gasket Manufacturer for recommended gasket material.

2.3 PIPE THREADS

A. Pipe threads shall be in conformance with ASME B1.20.1 - Pipe Threads, General Purpose (inch), and be made up with Teflon tape unless otherwise indicated.

B. Unless otherwise indicated, use metal FNPT and plastic MNPT for threaded pipe connections between metal and plastic pipes.

2.4 THREADED INSULATING CONNECTIONS

A. General

1. Threaded insulating bushings, unions, or couplings, as appropriate, shall be furnished for joining threaded pipes of dissimilar metals and for piping systems where corrosion control and cathodic protection are involved.

B. Materials

1. Threaded insulating connections shall be constructed of nylon, Teflon, polycarbonate, polyethylene, or other non-conductive materials, and shall have ratings and properties to suit the service and loading conditions.

2.5 MODULAR MECHANICAL SEALS FOR PIPING PENETRATIONS

A. Where indicated and where required in order to prevent flow of water or air, the passages of piping through wall sleeves and cored openings shall be sealed with modular interlocking link mechanical closures.

B. Individual links shall be constructed of EPDM rubber, be suitable for temperatures between minus 40 and plus 250 degrees F, and be shaped to fill the annular space between the outside of the pipe and the inside of the wall sleeve or cored opening.

C. Assemble the links using Type 316 stainless steel bolts and nuts to form a continuous rubber belt around the pipe.

D. Pressure plates under each bolt and nut shall be fabricated of a corrosion-resistant composite material.

E. After the seal assembly is positioned in the sleeve, tighten the bolts against the pressure plates to expand the rubber links and form the watertight seal.

F. Sizing and installation of sleeves and assemblies shall be in accordance with the manufacturer's recommendations.

G. Modular Mechanical Seals Manufacturer, or Equal

1. **EnPro Industries Company (GPT), Link-Seal**

2. **Proco Products, Inc., Pen-Seal**

PART 3 -- EXECUTION

3.1 GENERAL

A. This section specifies the general installation requirements for piping, valves, and related items and shall be installed in accordance with the manufacturer's technical data and printed instructions. Specific piping materials, systems, appurtenances, and related installation and testing requirements are specified in related sections of Divisions 01, 33, and 40, and as noted on the Drawings, Pipe and Valve Schedules.

B. Piping shall be installed in a neat and workmanlike manner, properly aligned and cut from measurements taken at the Site to avoid interferences with structural members, architectural features, openings, any existing pipes, and equipment. Exposed pipe shall afford maximum headroom and access to equipment, and where necessary piping shall be installed with sufficient slopes for venting or drainage of liquids and condensate to low points.

C. CONTRACTOR shall obtain the assistance of the pipe manufacturer to instruct the pipe fitters in the correct installation and support of the piping system. Valves and flanges attached to the pipe shall be provided with adequate supports.

D. Lined Piping Systems

1. The lining manufacturer shall take full responsibility for the complete, final product and its application.

2. Pipe ends and joints of lined pipes at threaded flanges shall be epoxy-coated in order to assure continuous protection.

3.2 INSTALLATION

A. Installation shall be free from defects. Prior to installation, each pipe length shall be carefully inspected, be flushed clean of any debris or dust, and be straightened if not true straight. Ends of threaded pipes shall be reamed and filed smooth. Groove ends shall be clean and free from indentations, projections, and roll marks in the area from the pipe end to the groove. Fittings shall be equally cleaned before assembly.

B. Supports and Anchors: Piping supports, thrust, and seismic restraints shall be provided where shown on the Drawing or where determined to be required in according to Section 40 05 07 - Pipe Supports. Where necessary to avoid stress on equipment or structural members, the pipe shall be anchored or harnessed. Expansion joints and guides shall compensate for pipe expansion due to temperature differences. Pipe shall be firmly supported with fabricated or commercial hangers or supports.

C. Piping Joints: Pipe joints requirements shall conform to the applicable piping sections of Division 33 and Division 40.

1. Threaded Joints: Pipe threads shall be full and cleanly cut with sharp dies. Not more than 3 threads shall remain exposed after installation.

2. Flange Joints: Flanged joints shall be made with gaskets with bolts and nuts as specified. Care shall be taken not to over-torque the bolts, in accordance with the manufacturer's written recommendations.

3. Fusion-Welded Joints: Fusion-welded joints shall be made with the manufacturer's recommended equipment on clean, dry pipe ends. The joints shall be made up at the recommended ambient temperatures, to the pipe manufacturer's written recommendations. The pipe supplier shall be consulted to obtain machinery and expertise for the joining by fusion welded of pipe and fittings. No pipe or fittings shall be joined by fusion by any of the Contractor's personnel unless they are adequately trained and qualified in the techniques involved. Butt fusion joining shall yield a joint strength equal to or greater than the tensile strength of the pipe. Socket fusion, extrusion welding and hot gas welding shall not be used for field connections.

4. Brazed and Soldered Joints: Brazed and soldered joints shall conform to the manufacturer’s recommendations and to the specifications and recommendations of ASME B 31.1 - Power Piping. Brazing shall be done by skilled and qualified welders. Prior to the application of flux, the ends of tubes shall be thoroughly dried and cleaned

5. Grooved Joints: Grooves for grooved couplings and fittings shall be made with specially designed grooving tools to the manufacturer's recommendations and conform to AWWA C 606 – Joints, Grooved and Shouldered Type. Grooves shall be clean and sharp without flaws, and the pipe ends shall be accurately cut at 90 degrees to the pipe axis.

6. Push On Joints: Push on joints and gasket installation shall be in accordance with the manufacturer's recommendations and lubricants. Pipe ends shall be beveled to facilitate assembly. Lubricants shall be suitable for potable water service and shall be kept clean in closed containers.

7. Solvent-Welded Joints: Solvent-welded joints shall be made with fresh primer and solvent cement on clean, dry pipe ends. The primer and cement cans shall be kept closed at all times and the joints shall be made up at the recommended ambient temperatures, to the pipe or cement manufacturer's written recommendations. PVC socket connections shall be joined with PVC cement conforming to ASTM D2564 Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC). CPVC socket connections shall be joined with CPVC solvent cement conforming to ASTM F493. For chemical service applications, solvent cement shall be formulated and labeled for use on that chemical.

8. Adhesive Joints: Adhesive joints shall be made with freshly-mixed 2-part epoxy on clean, dry pipe ends per pipe manufacturer recommendations. The joints shall be made up at the recommended ambient temperatures, to the pipe or adhesive manufacturer's written recommendations. Pipe ends shall be inserted to the full depth of the socket.

D. Valves and Unions: Unless otherwise indicated, connections to fixtures, groups of fixtures and equipment shall be provided with a shutoff valve and union, unless the valve has flanged ends. Unions shall be provided at threaded valves, equipment, and other devices requiring occasional removal or disconnection.

E. Branch Connections: Branch connections in horizontal runs of air and gas piping shall be made from the top of the pipe, to avoid drainage of condensate into the equipment. Unless otherwise indicated for threaded pipe connections between metal and plastic pipes, use metal FNPT and plastic MNPT.

1. Pipe ends and joints of lined pipes at threaded flanges shall be epoxy-coated in order to assure continuous protection.

F. Isolation Joints / Dielectric Protection: Provide electrically isolate connections between dissimilar metal piping connections. Electrical checks shall be made to assure no contact is made between dissimilar metal piping elements.

1. Use dielectric couplings specially designed for the prevention of galvanic reaction between dissimilar metals.

2. For flanged connections, use stainless steel bolts with isolation bushings, washers, and full-face flange gaskets.

G. Core Drilling: Where core drilling is required for pipes passing through existing concrete, core drilling locations shall be determined by radiograph of concrete construction in order to avoid damage to embedded raceways and reinforcing bars.

H. Coating: Exposed pipes shall be coated with a finish coat to the pipe manufacturer's standard protective coating, with the manufacturer's recommended prime coat and a finish coat in accordance with Section 09 96 00 - Protective Coating.

I. Low points in piping systems and driplegs in steam, gas, and air systems shall have drainage valves.

J. Care shall be taken to insure that piping flanges, mechanical-type couplings, sleeve-type couplings, flexible connectors, and expansion joints are properly installed as follows:

1. Gasket surfaces shall be carefully cleaned and inspected prior to making up the connection. Gasket shall be centered properly on the contact surfaces.

2. Connections shall be installed to prevent inducing stress to the piping system or the equipment to which the piping is connected.

3. Contact surfaces for flanges, couplings, and piping ends shall be aligned parallel, concentric, and square to each axis at the piping connections.

4. Flange Bolts

a. Flange bolts shall be initially hand-tightened with the piping connections properly aligned.

b. Bolts shall be tightened with a torque wrench in a staggered sequence to the recommended torque for the applicable piping material per AWWA or manufacturer's recommendation. Care shall be taken to avoid over-torquing the bolts especially on plastic flanged joints.

c. Harness, thrust restraint, and tie rod bolts used for sleeve couplings, flange coupling adapters, or flexible joints shall be tightened gradually and equally at diametrically opposite sides until snug, in order to prevent misalignment and to insure that all studs carry equal loads.

d. In order to prevent induced stress or misalignment, do not over-torque connections to adjoining pump or equipment. Flanges shall not be deformed nor cracked.

3.3 INSPECTION

A. After completion of the WORK, cuttings, joining and wrapping materials, and other scattered debris shall be removed from the Site. The entire piping system shall be in a clean and functional condition.

B. Inspection: Finished installations shall be carefully inspected for proper joints and supports, interferences, and damage to pipe, fittings, and coating. Temporary plugs and covers shall be removed from openings and floor drains. Defective WORK shall be repaired to the satisfaction of the field engineer or plumbing inspector.

3.4 FIELD TESTING FOR PRESSURE PIPING

A. Prior to enclosure or burying, piping systems shall be pressure tested as required in the Piping Schedule for a period of not less than two hours without exceeding the tolerances listed in the Piping Schedule. Where no pressures are indicated, the pipes shall be subject to 1-1/2 times the maximum working pressure. The CONTRACTOR shall furnish test equipment, labor, materials, and devices as part of the WORK. For additional testing requirements, refer to Section 01 74 30 - Pressure Pipe Testing.

B. Leakage may be determined by loss of pressure or other positive and accurate method. Fixtures, devices, or other accessories which are to be connected to the lines and which would be damaged if subjected to the test pressure shall be disconnected and ends of the branch lines plugged or capped as required during the testing procedures.

C. Leaks shall be repaired, and the system shall be re-tested until no leaks are found.

END OF SECTION

SECTION 40 05 02 - PIPING IDENTIFICATION

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide identification for the piping and valves of all meter vaults, valve vaults, the oxygen generation shed, and reuse water treatment building, complete and in place, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

ASME A13.1 Scheme for the Identification of Piping Systems

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals.

B. Shop Drawings: Provide a list of the suggested wording for each pipe label and valve tag, prior to fabrication.

C. Samples – Provide a sample of each type of identification device.

PART 2 -- PRODUCTS

2.1 EXPOSED PIPING OR ABOVE GROUND PIPING IDENTIFICATION

A. Pipe markers, type as indicated below, suitable for outdoor application from -40 degrees to 180 degrees Fahrenheit; in accordance with ASME A13.1 requirements.

1. Marker Type

a. Snap Around: Vinyl or polyester sheet with UV- resistant ink, preshaped and sized to tightly curl around the pipe and remain in position.

b. Adhesive: Vinyl or polyester sheet with UV- resistant ink, shaped similar to pipe curvature and coated with pressure sensitive adhesive.

c. Stencil: Lettering painted directly on surface of pipe inside color coded marker area.

2. Marker Area: Sized per pipe size according to ASME A13.1 and conforming to the color codes in the Identification Colors table below.

3. Lettering: Sized per pipe size according to ASME A13.1 and conforming to the color codes in the Identification Colors table below.

4. Arrows: At least one arrow at each marker area, showing direction of flow.

B. Pipe 1-inch diameter and smaller or pipe not suitable for the marker type(s) listed above shall be identified with aluminum or stainless steel pipe identification tags with stamped-in ¼” high identification lettering.

C. Manufacturer or Equal.

1. **Seton Identification Products**, Opti Code Pipe Markers (adhesive type)

2. **Grainger, Inc.** (adhesive, snap around)

3. **Marking Services, Inc.**(adhesive, snap around)

2.2 BURIED PIPELINE IDENTIFICATION

A. Underground Warning Tape

1. Material:

a. Polyethylene tape or polyolefin film. The material and ink shall be chemically inert and shall not degrade when exposed to acids, alkalis and other destructive substances commonly found in soil.

b. 6” wide tape with a minimum 4 mil thickness.

c. Message: “CAUTION, LINE BURIED BELOW” with the name of the fluid service in black lettering on a colored background.

1) Water: Blue

2) Sewer: Green. **Shall be used on all pipes of this project.**

3) Reuse Water: Purple

4) Gas and other services: Yellow

5) Other services: colors as approved by the OWNER.

2. Manufacturer, or Equal

a. **Reef Industries, Inc.**

b. **Seton Identification Products**

c. **T. Christy Enterprises, Inc.**

B. Tracer Wire

1. Material:

a. Solid copper conductor with 30 mil HMWPE.

b. 10 gauge or thicker wire.

2. Manufacturer, or Equal

a. **Kris-Tech Wire**

b. **Corrpro Companies, Inc.**

C. Witness Markers

1. Material:

a. UV resistant glass fiber and resin reinforced thermosetting composite material.

b. Constructed as a single pipe with pointer at the bottom end.

c. Message of the markers “CAUTION, LINE BURIED BELOW” with the name of the fluid service, and the following information:

1. Phone number for underground service alert.

2. Phone number for OWNER in case of emergency.

3. Application station number and offset information if marker is not directly over the pipe.

4. Name of buried appurtenance or fitting if applicable.

2. Manufacturers, or Equal

a. **Carsonite Composites, Utility Marker**

b. **Berntsen International, Inc.**

2.3 EXISTING IDENTIFICATION SYSTEMS

A. In installations where existing piping identification systems have been established, the CONTRACTOR shall follow the existing system. Where existing identification systems are incomplete, utilize the existing system as far as practical and supplement with the system indicated herein.

2.4 IDENTIFICATION OF VALVES AND SHORT PIPE LENGTHS

A. Valves and sections of pipe that are too short to be identified with markers and arrows shall be identified with metal or plastic tags.

B. Metal tags shall be stainless steel with embossed lettering. Plastic tags shall be solid black plastic laminate with white embossed letters. Tags shall be designed to be firmly attached to the valves or short pipes or to the structure immediately adjacent to the valves or short pipes.

C. Wording on valve tags shall describe the exact function of each valve (e.g., "HWR-BALANCING," "CLS THROTTLING", "RAS-PUMP SHUT-OFF," etc.) and include the valve number as indicated in the Contract Drawings. Wording on small pipes shall describe the contents of the pipe.

2.5 Pipe Coating:

A. Unless otherwise indicated, pipe coating shall be in conformance with Section 09 96 00 - Protective Coating.

PART 3 -- EXECUTION

3.1 GENERAL

A. Markers and identification tags shall be installed in accordance with the manufacturer's printed instructions, and shall be neat and uniform in appearance. Tags and markers shall be readily visible from all normal working locations.

3.2 VALVE TAGS

A. Valve tags shall be permanently attached to the valve or structure by means of 2 stainless steel bolts or screws.

3.3 MARKER LOCATIONS

A. Each pipe shall be marked at:

1. Intervals of 20-feet in straight runs.

2. At least once in every room.

3. Within 2 feet of turns, elbows, and valves.

4. On the upstream side of tees, branches, and other distribution points.

3.4 IDENTIFICATION COLORS

1. Conform to the following color codes.

Color Schedule				
Pipe Contents		**Pipe Color**	**Marker Color**	**Letter Color**
Abbreviation	**Identification**			
AIR	Air Release	White	blue	white
BW	Backwash	Brown	green	white
CLW	Cleaning Water	Brown	Brown	white
D	Drain	Green	green	white
DWS	Domestic Water Supply (chlorinated)	Blue	blue	white
OF	Overflow	Green	green	white
OX	Oxygen	Black	orange	black
SPW	Spawning Wastes	Brown	Brown	white

RW	Reuse Water	purple	purple	white
TD	Trench Drain	Brown	Brown	white
UW	Utility Water (non-potable)	White	Green	white
WS	Water Supply	Blue	blue	white

END OF SECTION

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SECTION 40 05 06 – PIPE COUPLINGS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide pipe couplings indicated, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 40 05 00 - Piping, General apply to the WORK of this Section

C. The provisions of this Section shall apply to piping in Divisions 33 and 40, and on the Drawings.

D. The couplings, adapters and joints shall be provided with restraining devices to restrict pipe axial movement. Where the restraining devices and/or details are not indicated on the Drawings, it is the CONTRACTOR'S responsibility to provide the devices/details necessary to restraint the piping system.

E. The Items specified in this section include the following:

1. Groove Couplings
2. Sleeve Couplings
3. Flanged Coupling Adapters
4. Dismantling Joints
5. Transition Couplings.
6. Flexible Expansion Joints
7. Miscellaneous Adapters

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Contractor Submittals.

B. Shop Drawings: Shop Drawings shall contain the following information:

1. Product submittals, and shall be specifically identified with the applicable style or series designation, pressure rating and restraint system if applicable.
2. Couplings schedule or layout indicating where the couplings will be installed.
3. Expansion Joints: Submit detailed calculations and manufacturer's Shop Drawings of proposed expansion joints, piping layouts, and guides, including information on materials, temperature, and pressure ratings
4. Flexible Couplings/Connectors: Submit pressure and thermal expansion calculations

C. Certifications

1. Necessary certificates, test reports, and affidavits of compliance shall be obtained by the CONTRACTOR.

1.3 MATERIAL DELIVERY, STORAGE, AND PROTECTION

A. Piping couplings, adapters and joints accessories shall be delivered in a clean and undamaged condition and stored off the ground for protection against oxidation caused by ground contact.

B. Defective or damaged materials shall be replaced with new materials.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Extent of Work

1. Piping couplings, adapters, joints and accessories shall be provided in accordance with the requirements of the applicable Sections of Divisions 33 and 40 and as indicated.

2. The CONTRACTOR shall not be allowed to substitute any other type of coupling in lieu of the couplings as specified herein unless approved by the ENGINEER.

3. The CONTRACTOR shall assign the responsibility to the coupling manufacturer to review the piping connection to the equipment and submit any modifications to the ENGINEER for review.

B. Pressure Rating

1. Couplings, adapters and joints shall be designed for the pressure as defined in respective pipe sections, or as indicated on the Piping Schedule, whichever is greater.

C. Seals

1. Seal elastomer materials shall be selected to be compatible with the fluid service, pressure and temperature. They shall be composed of elastomeric-compound material that will not deteriorate from age under normal storage or use conditions.

2. Where couplings are used in water containing dissolved ozone residual or chloramines, seal material shall be Viton-A.

D. Coating

1. Couplings shall be lined and coated at the factory, unless otherwise indicated.

2. Coating shall be in accordance with the Section 09 96 00 - Protective Coating, unless otherwise indicated.

2.2 SLEEVE COUPLINGS

A. General

1. Provide sleeve couplings specifically designed suitable for the fluid service and pressure rating.

B. Construction

1. Sleeve couplings shall be in accordance with AWWA C219 - Standard for Bolted Sleeve-Type Couplings for Plain-End Pipe.

2. Couplings shall be constructed without pipe stop.

3. The middle ring shall be at least the same wall thickness as the pipe to which the coupling is connected and not less than 1/4-inch thick.

4. If the strength of the middle ring material is less than the strength of the pipe material, the thickness of the middle ring shall be increased to have the same strength as the pipe.

5. For standard sleeve couplings, the coupling shall be either 5 or 7 inches long for pipe diameters up to and including 30-inch and 10 inches long for pipe diameters greater than 30-inch. For long sleeve couplings, the coupling shall be 16 inches long for all pipe diameters.

6. The followers shall be single-piece contoured mill sections welded and cold-expanded as required for the middle rings and of sufficient strength to accommodate the number of bolts necessary to obtain adequate gasket pressures without excessive rolling.

C. Insulating Sleeve Couplings

1. Where insulating couplings are required, both ends of the coupling shall be provided with a wedge-shaped gasket which assembles over a sleeve of an insulating compound material compatible with the fluid service in order to obtain insulation of coupling metal parts from the pipe.

D. Sleeve-Type Couplings Manufacturer, or Equal

1. **World Wide Metric, Inc.** (Dresser), Style 38

2. **Ford Meter Box Company, Inc.,** Style FC1 or FC3

3. **Smith-Blair, Inc.,** Style 411

2.3 FLANGED COUPLING ADAPTERS

A. Provide flanged coupling adapters specifically designed suitable for the fluid service and pressure rating.

B. Construction

1. Coupling bodies shall be fabricated from steel, ASTM A 512 - Cold-Drawn Butt-Weld Carbon Steel Mechanical Tubing or A 513 - Electric-Resistance Welded Carbon and Alloy Steel Mechanical Tubing.

2. Provide flanges in conformance with AWWA C207.

3. The body shall be at least the same wall thickness as the pipe to which the coupling is connected, but not less than 1/4 inch thick.

4. If the strength of the body material is less than the strength of the pipe material, the thickness of the middle ring shall be increased to have the same strength as the pipe.

5. The follower flange shall be fabricated from steel, ASTM A 576 - Steel Bars, Carbon, Hot Wrought, Special Quality or AISI C1012.

C. Flanged Couplings Adapter Manufacturer, or Equal

1. **Smith-Blair**, Model 913

2. **Dresser**, Model 128-W

3. **JCM**, Model 303

2.4 DISMANTLING JOINTS

A. Provide dismantling joints products specifically designed suitable for the fluid service and pressure rating.

B. Construction

1. Coupling bodies shall be fabricated from steel, ASTM A 512 - Cold-Drawn Butt-Weld Carbon Steel Mechanical Tubing or A 513 - Electric-Resistance Welded Carbon and Alloy Steel Mechanical Tubing.

2. Provide flanges in conformance with AWWA C207.

3. The body shall be at least the same wall thickness as the pipe to which the coupling is connected, but not less than 1/4 inch thick.

4. If the strength of the body material is less than the strength of the pipe material, the thickness of the middle ring shall be increased to have the same strength as the pipe.

5. The follower flange shall be fabricated from steel, ASTM A 576 - Steel Bars, Carbon, Hot Wrought, Special Quality or AISI C1012.

C. Dismantling Joints Manufacturer, or Equal

1. **Smith-Blair**, Model 975

2. **Dresser**, Model 131

3. **JCM**, Model 309

2.5 TRANSITION COUPLINGS

A. Provide transition-coupling products specifically designed suitable for the fluid service and manufactured for the piping applications.

B. The transition couplings shall have function and design similar to the flexible couplings, joint and flanged coupling adapters for connecting piping having different outside diameters.

2.6 MISCELLANOUS ADAPTERS

A. A special pipe adapter may be required to provide proper connection between different type of pipes and/or fittings. The adapter may be indicated on the Drawing with the pipe type or equipment. However, it is the CONTRACTOR'S responsibility to ensure proper connection between various type of pipes and pipe appurtenances. Provide adapters as required whether specifically indicated or not.

B. Provide piping adapter products specifically designed suitable for the fluid service and manufactured for the piping applications.

PART 3 -- EXECUTION

3.1 GENERAL

A. Installation, inspection and field testing of the pipes shall in accordance with the requirements of Section 40 05 00 - Piping, General.

B. The CONTRACTOR shall have the coupling manufacturer's service representative verify the correct choice and application of couplings and gaskets, and the workmanship, to assure a correct installation.

C. The CONTRACTOR shall assign the responsibility to the couplings manufacturer to review the piping connection to the couplings and submit any modifications to the ENGINEER for review.

3.2 INSTALLATION

A. Where couplings are shown to connect piping to mechanical equipment such as pumps, compressors, and blowers, the piping shall be aligned with the equipment point of connection and shall be perpendicular to the axis of the flange or fitting for which the piping is to be connected.

B. The couplings or the piping shall not impose excessive stress to the equipment connection to cause misalignment of the equipment.

C. Restrained Joints on couplings, adapters and joints

1. Couplings, adapters and joints on pressure lines shall be harnessed unless thrust restraint is provided by other means.

2. Harnesses shall be designed by the pipe manufacturer in accordance with AWWA Manual M11, or as indicated.

3. Harness sets shall be designed for the maximum test pressure of the pipe in which they are installed.

4. Where harness sets are installed near the suction and discharge of the pump, harness bolts shall have zero elongation in order to prevent misalignment of the pump imparted by the thrust within the piping system.

END OF SECTION

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SECTION 40 05 07 - PIPE SUPPORTS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide pipe supports, hangers, guides, and anchors, complete and in place, as indicated in accordance with the Contract Documents.

B. Where pipe support systems are not indicated on the Drawings, the CONTRACTOR shall design and provide the supports in accordance with this Section. The absence of pipe supports and details on the contract drawings does not relieve the Contractor of responsibility for sizing and providing the pipe supports.

C. The provisions of this Section shall apply to piping in Divisions 33 and 40.

D. The CONTRACTOR shall provide supporting devices for supporting and restraining piping as indicated on the Drawings. Where pipe support devices and/or restraining details are not indicated on the Drawings, it is the CONTRACTOR'S responsibility to develop the details necessary to support and restraint the piping for a complete and functional pipe support system.

E. Seismic and Wind Forces

1. Pipe support details indicated in the Contract Drawings are sized for gravity loads only, and not designed to resist seismic and wind forces.

2. The CONTRACTOR shall arrange for the services of a registered professional engineer experienced in pipe support design to design such pipe supports to resist seismic and wind forces.

3. Piping support seismic and wind loads shall be sized in accordance with Section 01 33 17 – Structural Design, Support and Anchorage.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals.

B. Shop Drawings

1. Submit Shop Drawings which shall include the following information:

a. Drawings of pipe supports, hangers, anchors, and guides.

b. Pipe support schedule or layout indicating where the supports will be installed.

c. Where indicated, calculations for special supports and anchors, stamped and signed by a registered professional engineer in the state where the project is located.

PART 2 -- PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Code Compliance

1. 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, and probable forces applied during construction as well as stresses on piping, equipment, and structures.

2. Supports and parts thereof shall conform to the requirements of ASME B31.1 - Power Piping – Chapter II, Part 5 -Expansion, Flexibility, and Pipe Supporting Element and design the pipe supporting elements in accordance with the rules of MSS SP-58 -Pipe Hangers and Supports – Materials, Design and Manufacture, except as supplemented or modified in this Section.

3. Supports for plumbing piping shall be in accordance with the latest edition of the applicable plumbing code or local administration requirements.

B. Structural Members

1. Wherever possible, pipes shall be supported from structural members.

2. Where it is necessary to frame structural members between existing members, such supplementary members shall be provided by the CONTRACTOR.

3. Supplementary members shall be in accordance with the requirements of the Building Code and the American Institute of Steel Construction, and shall be as acceptable to the ENGINEER.

C. Pipe Hangers

1. Pipe hangers shall be capable of supporting the pipe in operation, allowing free expansion and contraction of the piping and preventing excessive stress on equipment.

2. Hangers shall have a means of vertical adjustment after erection.

3. Hangers shall be designed to prevent becoming disengaged by any movement of the supported pipe.

4. Hangers subject to shock, seismic disturbances, or thrust imposed by the actuation of safety valves shall include hydraulic shock suppressors.

5. Hanger rods shall be subjected to vertical loading only.

D. Hangers Subject to Lateral or Axial Movement.

1. At hanger locations where lateral or axial movement is anticipated, suitable linkage shall be provided to permit such movement.

2. Where lateral or axial pipe movement is greater than 1/2 inch, or where the hanger rod deflection from the vertical is greater than 4 degrees from the cold-to-hot position

of the pipe, the hanger rod and structural attachment shall be offset in such a manner that the rod is vertical in the hot position.

E. Riser Supports

1. Where practical, risers shall be supported on each floor with riser clamps and lugs, independent of the connected horizontal piping.

F. Materials of Construction

1. Pipe support assemblies, including framing, hardware, and anchors, shall be of steel construction, galvanized after fabrication, unless otherwise indicated.

2. Submerged supports, as well as piping, conduits, and equipment in hydraulic structures located two feet above water level, shall be supported with support assemblies, including framing, hardware, and anchors constructed of Type 316 stainless steel, unless otherwise indicated.

G. Point Loads

1. Meters, valves, heavy equipment, and other point loads on PVC, FRP, or other plastic pipes, shall be supported on both sides, according to manufacturer's recommendations, in order to avoid undue pipe stresses and failures.

2. In order to avoid point loads, the supports on PVC, FRP, or other plastic piping shall be equipped with extra wide pipe saddles or galvanized steel shields for general service and Type 316 stainless steel shields for chemical or corrosive areas.

H. Concrete Anchors

1. 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.

2. Anchor embedment shall be in accordance with the requirements of Section 05 05 19 Post-Installed Anchors in Concrete and Section 05 50 00 – Miscellaneous Metalwork.

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, expansion anchors, or epoxy anchors. Epoxy anchors are not permitted for vertical hanging applications or where sustained tension is exerted on the anchor. Exceptions: 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 degree F or higher than the limiting temperature recommended by the manufacturer.
Vibratory Loads and High-Temperature Conditions	Use non-shrink grouted anchors.

2.2 SUPPORT SPACING

A. Supports for piping with the longitudinal axis in approximately a horizontal position shall be spaced to prevent excessive sag, bending, and shear stresses in the piping, with special consideration given where components such as flanges and valves impose concentrated loads.

B. Where pipe spacing are indicated on the Drawings and are referenced to a Standard Detail, that requirement shall take preference over the general requirements of this section.

C. Pipe support spacing shall not exceed the maximum indicated spans. Piping with grooved joint couplings, flexible joints, and bend fittings shall be balanced supported by a minimum of two pipe supports per pipe length, one at near each joint/fitting.

D. For temperatures other than ambient temperatures or those listed, and for other piping materials or wall thicknesses, the pipe support spacings shall be modified in accordance with the pipe manufacturer's recommendations.

E. Vertical supports shall be provided to prevent the pipe from being overstressed from the combination of loading effects.

F. Ductile Iron Pipe

1. Install supports for ductile iron pipe in accordance with the recommendations of the Ductile Iron Pipe Research Association (DIPRA) Design of Ductile Iron Pipe on Supports.

2. As a minimum, where support spacing is not indicated on the Drawings, the CONTRACTOR shall use the spacing indicated in the following schedule:

Nominal Pipe Diameter, inches	Support Configuration
All diameters	two supports per pipe length, with one of the two supports located at a joint

G. Copper Tube

1. Where support spacing is not indicated on the Drawings, the CONTRACTOR shall use the spacing below:

Nominal Tube Size, inches	Support Spacing, feet	
	Water Service	Vapor Service
¾ and smaller	5	5
1	6	8
1-1/2 to 2-1/2	8	10
3	10	14
4	12	16
5	13	18
6	14	20
8	16	23

H. Schedule 80 PVC Pipe

Nominal Pipe Size, inches	Support Spacing, feet
1	5
1-1/2	5.5
2	6
3	7
4	7.5
6	9
8	9.5
10 and larger	10

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I. Other Pipe Materials

1. Support spacing for pipe constructed of other materials shall be based on design temperature and in accordance with the pipe manufacturer's recommendations.

2.3 MANUFACTURED SUPPORTS

A. Stock Parts

1. Where not specifically indicated, designs that are generally accepted as exemplifying good engineering practice and using stock or production parts shall be utilized wherever possible.

2. Such parts shall be locally available, new, of best commercial quality, and designed and rated for the intended purpose.

B. Manufacturers, or Equal

1. **Basic PSA, Inc.**

2. **Bergen-Paterson Pipe Supports Group**

3. **Grinnell**

4. **Power Piping Company**

5. **TOLCO (Eaton B-Line)**

2.4 COATING

A. Unless otherwise indicated, fabricated pipe supports other than stainless steel or non-ferrous 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 and shall receive protective coatings in accordance with the requirements of Section 09 96 00 – Protective Coating.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. General

1. Pipe supports, hangers, brackets, anchors, guides, and inserts shall be installed in accordance with the manufacturer's printed instructions and per ANSI/MSS SP-58 Pipe Hangers and Supports- Materials, Design, Manufacture, Selection, Application and Installation.

2. Embedded 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 slope for drainage and venting, as close to ceilings or roofs as possible, and without interference with other WORK.

3.2 FIELD FABRICATION

A. Quality Control

1. Field fabricated pipe hangers and supports shall be fabricated and installed by experienced welders and fitters, using the best welding procedures available.

2. Hangers and supports shall be neat in appearance without sharp corners, burrs, or edges.

END OF SECTION

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SECTION 40 05 24 - STEEL PIPE (ASTM A 53/A 106, MODIFIED)

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide steel pipe and appurtenances, complete and in place, in accordance with the Contract Documents.

B. The requirements of Section 40 05 00 - Piping, General and 40 05 07 – Pipe Supports apply to the WORK of this Section.

PART 2 -- PRODUCTS

2.1 PIPE MATERIAL

A. Water, Air, Fuel Gas, Oil, Steam, and Waste Service: Unless otherwise indicated, galvanized and black steel pipe shall conform to ASTM A 53 Type E or S- Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless or ASTM A 106 - Seamless Carbon Steel Pipe for High Temperature Service, Grade B, and shall be Schedule 40 or 80, as indicated in the Piping Schedule. Galvanized steel pipe shall not be cement mortar lined unless so indicated.

2.2 PIPE JOINTS

A. Black steel pipe for general service shall have threaded ends with NPT threads, welded joints, or flanged joints. Threaded joints shall be made up with Teflon tape and welded joints may have butt-weld fittings, socket-weld fittings, or flanges. Where indicated, black steel pipe shall have grooved ends for shouldered couplings or plain ends for sleeve-type couplings.

B. Black steel pipe for chlorine or sulfur dioxide pressure service shall be socket-welded except where required to match mating fittings of vacuum regulator-check units, gas filters, valves, diaphragm units, gauges, and switches.

C. Galvanized steel pipe shall have threaded ends with NPT threads made up with Teflon tape. Where indicated, galvanized steel pipe shall have grooved ends for shouldered couplings or plain ends for sleeve-type couplings.

D. Where pressure conditions permit, black and galvanized steel pipe may have push-on joints for compression type fittings. For high pressure service these joints shall be harnessed.

2.3 FITTINGS

A. Common Use: The following fittings shall be provided for galvanized or black steel pipe, as indicated in the Piping Schedule:

1. Threaded malleable iron fittings conforming to ASME B 16.3 - Malleable-Iron Threaded Fittings, Classes 150 and 300.

2. Threaded cast iron fittings conforming to ASME B 16.4 - Cast Iron Threaded Fittings, Class 125 and 250.

3. Forged steel socket welded fittings conforming to ASME B 16.11 - Forged Fittings, Socket - Welding and Threaded.

4. Butt welding fittings conforming to ASME B 16.9 - Factory-Made Wrought Steel Butt Welding Fittings, Schedule 40 or 80, as indicated.

5. Threaded cast iron drainage fittings conforming to ASME 16.12 - Cast Iron Threaded Drainage Fittings.

6. Flanged steel fittings conforming to ASME B 16.5 - Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys.

7. Grooved ductile iron fittings with grooving dimensions conforming to AWWA C606 - Joints, Grooved and Shouldered Type.

8. Compression-type steel fittings with armored Buna S gaskets for plain end pipe.

B. Special Applications

1. Fittings for chlorine and sulfur dioxide under pressure shall be Class 3000. forged steel socket welded fittings conforming to ASTM A 105, Grade 2 - Forgings, Carbon Steel, for Piping Components, and Class 3000. forged steel fittings conforming to ASME B 16.11, as indicated in the Piping Schedule.

2. Flanges for chlorine and sulfur dioxide pressure service shall conform to ASTM A 105, ASME B 16.5, Class 300, with 1/16-inch raised face, with 1/16-inch high temperature, compressed, self-centering ring type gaskets to ASME B 16.21 - Nonmetallic Flat Gaskets for Pipe Flanges.

3. Unions shall be 4 bolt tongue and groove, ammonia type, suitable for chlorine and sulfur dioxide service, with female threads and lead gaskets. Unions shall be rated for 500 lb. CWP service pressure, reducing-type, straight-type or blind-type, as required for the installation. Blind unions shall be provided as cleanouts where indicated, and straight unions shall be provided adjacent to each threaded valve or piece of equipment. Unions shall be as manufactured by **Henry Valve Company, Vogt Valve Co.,** or equal. High tensile alloy steel corrosion-resistant bolts and nuts shall be used with each set of flanged unions.

PART 3 -- EXECUTION

3.1 GENERAL

A. Installation, inspection and field testing of the pipes shall in accordance with the requirements of Section 40 05 00 - Piping, General.

END OF SECTION

SECTION 40 05 30 - POLY VINYL CHLORIDE PRESSURE PIPE (ASTM D 1785, MODIFIED)

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide polyvinyl chloride (PVC) pressure pipe and appurtenances, complete and in place, in accordance with the Contract Documents.

B. The requirements of Section 40 05 00 - Piping, General and Section 40 05 07 – Pipe Supports apply to the WORK of this Section.

C. This Section includes PVC pressure pipe with solvent-welded, flanged, or threaded joints. PVC pipe with bell and spigot joints is included in Section 33 95 50 - PVC Pressure Pipe, Rubber Joints.

PART 2 -- PRODUCTS

2.1 PIPE MATERIAL

A. PVC pipe shall be made from new rigid unplasticized polyvinyl chloride and shall be normal impact Type 1, Grade 1, class 12454, Schedule 80, listed as compliant with NSF Standard 61, unless otherwise indicated, in accordance with ASTM D 1785 –Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.

2.2 PIPE JOINTS

A. Pipe joints shall be solvent-welded type with solvent cement and primer as recommended by the pipe manufacturer for the fluid in the pipe.

B. Threaded joints that are necessary to match up to threaded valves or fittings shall be made up with appropriate thread sealant, either paste or tape. Pipe threads shall conform to ASTM F 1498 - Taper Pipe Threads 60 Degrees for Thermoplastic Pipe and Fittings and shall be full and cleanly cut with sharp dies or molded.

C. Flanged joints shall be made with solvent-welded PVC flanges, drilled to ASME B 16.5 - Pipe Flanges and Flanged Fittings, Class 150, unless otherwise indicated.

2.3 FITTINGS

A. Solvent Welded and Threaded Fittings: Solvent-welded and threaded fittings shall be Schedule 80 PVC fittings in accordance with ASTM D 2467 - Socket-Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.

B. Flanged Fittings: Flanged fittings shall be Schedule 80 fabricated PVC fittings with Class 150 flanges in accordance with ASME B 16.5 - Pipe Flanges and Flanged Fittings, Class 150.

2.4 SOLVENT CEMENT

A. Solvent cement shall be in accordance with ASTM D 2564 and certified by the manufacturer for the service of the pipe.

B. Potable Water Applications: Solvent cement listed by NSF for potable water applications.

C. Manufacturer: IPS Corporation, or equal.

PART 3 -- EXECUTION

3.1 GENERAL

A. Installation, inspection and field testing of the pipes shall in accordance with the requirements of Section 40 05 00 - Piping, General.

END OF SECTION

SECTION – 40 90 10 CONTROL STRATEGIES

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The Contractor, through the use of the System Supplier, shall provide all PLC-Based Control System (PBCS) application programming required to implement the control strategies described in this section, the functions shown on the Drawings and I/O schedules complete and operable in accordance with the Contract Documents.

B. The control strategies in this section are intended to describe the general operation of the systems and processes and address systems that are required to be installed or modified as part of this project and to describe the general operation of the systems and processes. The control strategies are not intended to be all-inclusive operational procedures for the operation of the complete facility. The Contractor shall make refinements, modifications, and additions to these strategies as needed.

C. The requirements in this section include programming and integration of all PLC and Workstation and all other programming of PBCS interface, network, and communication devices.

1.2 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. The requirements of Section 40 91 00 – SCADA Systems and Equipment, apply, and are integral part to this Section.

1.3 ACTION SUBMITTALS/ INFORMATIONAL SUBMITTALS

A. The PLC submittal shall be provided in accordance with the requirements specified in Section 40 91 00 - SCADA Systems and Equipment.

1.4 COMMON FUNCTIONS

A. The following abbreviations are used throughout this section:

A/M	AUTO/MANUAL (Selector Switch)
DOW	Day of the Week
FVNR	Full-voltage non-reversing “across-the-line” (motor starter)
H/O/A	HAND/OFF/AUTO (Selector Switch)
H/O/R	HAND/OFF/REMOTE (Selector Switch)
HMI	Human-Machine Interface (display)
I/O	Input/Output (to & from the PLC)
LCP	Local Control Panel
L/O/R	LOCAL/OFF/REMOTE (Selector Switch)
L/R	LOCAL/REMOTE (Selector Switch)
O/A	OFF/AUTO
PLC	Programmable Logic Controller
PRAS	Partial Recirculating Aquaculture System

RTU	Remote Terminal Unit
SS	Selector Switch
S/S	START/STOP
VCP	Vendor Control Panel (vendor supplied)
VFD	Variable Frequency Drive (Adjustable Speed Drive)

B. Common functions that are generally applicable to all loops or to many similar loops are described under the heading "General Control Loop Functions." These functions are not repeated in the descriptions for each individual control strategy.

C. General Control Loop Functions

1. The following terms are used in the descriptions of PLC functions:

   a. Operator setpoints: Operator set or entered values shall be constants that are adjustable or set from operator displays. Examples of operator set or entered values are controller set points, time delays, etc. with operator level password.

   b. Supervisor setpoints: Supervisor set or entered values shall be constants that are adjustable or set from operator displays with supervisor level password.

   c. Engineer setpoints: Engineer setpoints are constants that are adjustable at engineer level displays/with an engineering level password without requiring any software reconfiguration. These values are not adjustable from operator level displays.

2. The following general control system functions shall be provided:

   a. The HMI manufacturers standard password entry scheme for user login and logout.

   b. The HMI manufacturers standard setpoint/numerical entry scheme.

   c. The HMI manufacturers standard alarm display and history scheme.

   d. The HMI manufacturers standard data trending scheme.

D. Analog and Discrete Inputs and Outputs

1. All analog and discrete inputs and outputs to the PLC shall be displayed. Both RUNNING and OFF input states shall be displayed.

2. All analog inputs shall have instrument failure alarms when the input is below 0 percent or above 100 percent for an engineering setpoint initially set at 10 seconds.

3. All discrete FAIL inputs shall be alarmed. Other discrete inputs shall be alarmed as noted in the control strategy descriptions and PLC I/O list.

4. Where alarms are specified in the control strategy descriptions, alarms shall be initiated from the applicable inputs. If discrete inputs are not available, the specified alarms shall be initiated from the applicable analog input; alarm setpoints shall be operator adjustable.

5. All analog inputs shall be trended.

6. All equipment run times shall be totalized and recorded. All totalized values shall be displayed.

7. Displays shall be grouped functionally for ease of operation. Both analog and discrete functions associated with an item of equipment or a group of equipment shall be provided on the same display.

8. Unless otherwise stated or shown, all discrete outputs shall be maintained outputs. For START/STOP PLC functions, the PLC shall issue a maintained START command until a FAIL state is detected or when a STOP command is issued. When a momentary command is required, the PLC shall issue the command for 2 seconds, then remove the signal.

9. For equipment that is controllable from the PLC, a control mode status signal will be sent to the PLC to indicate when the PLC is allowed to control the equipment. The PLC shall monitor the control mode status (LOCAL/ REMOTE, etc.) and attempt to control only that equipment which is in the REMOTE mode.

10. For equipment that the PLC is allowed to control, the PLC shall provide a FAIL alarm if the equipment fails to comply with a PLC command signal (START, STOP, OPEN, CLOSE) that has been present for more than an engineering setpoint time period. In this event, the command shall be removed subsequent to the expiration of the engineering setpoint time period.

11. For equipment that is controllable from the PLC in either a MANUAL or AUTOMATIC mode, the operator shall be provided with a software AUTO/MANUAL selector switch at the Human-Machine Interface (HMI). Transfer between the MANUAL and AUTOMATIC modes shall be bumpless.

12. When equipment is tagged OUT OF SERVICE, by the operator, all associated equipment shall have their alarms inhibited until the tagged equipment is re-tagged IN SERVICE.

13. All pumps that were running before a power outage shall be immediately restarted following restoration of power.

14. Initial specific values for beginning pre-startup testing are noted in the process control strategy descriptions. These values will be adjusted based upon operating experience.

1.5 FUNCTIONS AND CONTROL MODES

A. The term Plant Control System (PCS) is used as a generic representation of any type of control system, independent of the technology used to control a facility. The control system will be a PLC based system to match the OWNER's existing system.

B. Functions

1. LOCAL: The term "LOCAL" means "in the field" i.e. at the physical location of the equipment. Local control means at the equipment or control from the starter panel.

2. REMOTE: The term “REMOTE” means away from the equipment. Remote control means ability to control the equipment at the control panel/PLC or from the HMI away from the equipment or away from the starter panel.

3. Local Control Panel (LCP): refers to the presence of a field-situated panel, which serves as a control location. Usually, this panel contains a PLC.

4. Local Display: This function refers to the display of equipment status or process variable at a location in the field, local to the equipment.

5. Local Interlock: This function refers to the presence of field-situated control logic in which the status of other equipment directly effects the operation and control of the equipment being controlled.

6. Control System Alarms and Status: Variable or status data to be alarmed in the Hatchery Building.

7. Local Alarms: Alarms that are announced in the field.

8. Set Points: Values which are adjustable at the engineer (supervisor) level displays without requiring any software configuration. These values are not adjustable by the operator from the display station. Whenever a LOCAL/REMOTE set point selection is provided, in LOCAL, the set point shall be adjustable from the equipment. In REMOTE, the set point shall be adjustable from a REMOTE set point input.

C. Control Modes

1. Local Manual Control Mode: This mode enables manual control proximal to the equipment. The equipment is then manually controlled (e.g. START, STOP, OPEN-STOP-CLOSE, etc.) by a local selector switch station by switching it to “HAND” or “OFF”, or “OPEN-STOP-CLOSE”. The control logic and set points in the plant control system PLC are bypassed and do not affect the operation of the equipment. All the controls from the HMI are disabled.

2. Local Automatic Control Mode: This mode enables automatic control that is provided and performed external to the PLC. In some cases, the equipment of the facility is pre-packaged with a Local Control Panel complete with its own automation logic.

3. Remote Manual Control Mode: This mode allows control from the HMI. The operator switches the “Auto/Manual” switch at the HMI to “MANUAL” position to enable manual operation from the HMI. In this position the operator is able to “START”, “STOP”, “OPEN”, CLOSE” etc. the equipment, or manually change the control output to the equipment. Consequently, in this position the automatic control logic and set points in the PCS controller are overridden. In this mode the local control system is also bypassed except for equipment safety interlock.

4. Remote Automatic Control Mode: This mode allows control of the equipment from the HMI and PLC. The operator at the control room switches the “AUTO/MANUAL” switch at the HMI to “AUTO” position to enable PCS automatic operation. In this mode the equipment is controlled automatically by the control logic and set points residing in the PLC. The supervisor is able to change operational parameters through the HMI by entering new set points. A control mode status signal will be sent to the PLC to indicate when the PLC is allowed to control the equipment. The PLC shall monitor

the control mode status (LOCAL/ REMOTE) and attempt to control only that equipment which is in the REMOTE mode.

D. General Control and Mode Switches Terms

1. "LOCAL-OFF-REMOTE" Switch: For the purpose of this definition and for simplicity, it is assumed that this switch is located at the local starter panel.

   a. LOCAL Position: In this position equipment automation and control from the control panel/PLC are bypassed. The control is being delegated away from the PLC. Control from the HMI is also disabled.

   b. OFF Position: In this position all equipment control functions are off and disabled.

   c. REMOTE Position: In this position equipment, automation and control are available from the PLC. An AUTO-MANUAL and a START-OFF-STOP switch (or OPEN-OFF-CLOSE) shall be provided at the operator HMI workstation from which remote manual control is performed.

2. "HAND-OFF-AUTO" Switch: This switch is located usually at the LCP. Control through this switch is performed from the LCP only if the LOCAL-OFF-REMOTE switch at the starter panel is in LOCAL position as discussed above. All the control functions are performed locally and external to the PLC.

   a. HAND Position: in this position the equipment is started manually.

   b. OFF Position: The equipment is off.

   c. AUTO: In this position the equipment is automatically controlled locally and external to the PLC by local control hardware.

3. HMI Switches:

   a. For equipment that is controllable from the PLC in either a MANUAL or AUTOMATIC mode, the operator shall be provided with a software "AUTO-MANUAL" selector switch at the operator HMI workstation. This switch is functional only when LOCAL-OFF-REMOTE switch in the field is in REMOTE position. The following are the AUTO- MANUAL functions:

      1) AUTO – In this position the operator delegates and enables the automation and control functions of the equipment to be performed at the PLC/control panel in the field. The operator is unable to manually control the equipment from the HMI.

      2) MANUAL – In this position the operator is able to override the control functions in the PLC and remotely control the field equipment manually from the HMI.

   b. A second software switch such as "START-OFF-STOP" or OPEN-STOP-CLOSE", etc. or as required by the application, shall be provided in the HMI to control the equipment in the field manually from the HMI. Variations of these types of control switches shall be provided for the equipment based on its control application. These switches shall be functional only when the above "AUTO-MANUAL" switch is in "MANUAL" mode.

1.6 CONTROL STRATEGY CONTENTS

A. Control Strategy General Description: The control strategy general description provides a narrative of the process, its related equipment, as well as the function, the philosophy and methodology of the process control. It provides guidelines for programming the control functions. The general description together with detailed loop by loop functional description and other section of the strategy comprise the design criteria of the process control.

B. Detail Loop Description: This part describes the applicable loops in the control strategy and every mode of operation. The narrative should include an explicit description of what each loop monitors and what and how each element in the control loop functions and controlled in various modes of operation. Each loop description contains the required functionality needed to support control system process graphic screens.

C. Common Functions

1. The following list of Common Control Features shall be implemented on all equipment and as stated in the individual control strategies listed within these specifications.

a. The “Soft I/O” signals described in this document are provided for the CONTRACTOR’S convenience and represent the minimum signals to be derived for the monitoring and control of the equipment. The Contractor shall provide all necessary additional software-derived signals to meet the control strategies at no additional cost to the OWNER.

b. Analog instrumentation failure feature:

1) Out of Range Alarm: All analog inputs shall have a unique instrument failure alarm when the input is below 0 percent or above 100%. This alarm shall be displayed on the HMI as an Out-of-Range alarm.

2) If an analog signal is used to control the operation of the equipment from the PLC, the equipment shall remain running at its last valid set point until the analog instrumentation is stable for a tunable time setting.

c. Unless otherwise stated or shown, all discrete outputs shall be maintained outputs. For START/STOP PLC functions, the PLC shall issue a maintained START command until a FAIL state is detected or when a STOP command is issued. When a momentary command is required, the PLC shall issue the command for 2 seconds and then remove the signal.

d. Pump Control and Status Discrepancies Programming:

1) In general, for equipment that the PLC is allowed to control, the PLC shall provide a FAIL alarm if the equipment fails to comply with a PLC command signal (START, STOP, OPEN, CLOSE) that has been present for more than a tunable time period. In this event, the command shall be removed subsequent to the expiration of the tunable time period.

2) A discrepancy/fail alarm shall be generated for any pump or final control element if a discrepancy exists between a system or operator command and the device status. For example, the system commands to start ("CALL") and the pump fails to start ("RUN" status report back) within a

programmable time delay, then a discrepancy ("FAIL") alarm shall be generated.

3) Likewise, involuntary change in the device's status shall also generate an alarm. For example, a pump starts when not commanded to do so, or a pump shuts down while running even though it still has a command to run.

4) A "FAIL" alarm shall not be generated even if the pump is intentionally started or stopped by an operator switching the HMI control switch to "START" or "OFF" position. However, if the operator turns the switch to “START” position and the pump has not started, a fail alarm shall be announced at the control center. Furthermore, if the operator turns off a pump and the pump has not stopped, an alarm shall also be announced at the control center. All fail alarms shall be delayed by an adjustable time delay 0-90 seconds.

e. All pumps shall be immediately restarted following restoration of power – either from the utility or the generator.

f. Wherever two or more pieces of equipment are provided for the same functions, for example sump pumps, the SCADA system shall alternate the equipment after each use.

g. Where alarms are specified in the control strategy descriptions, alarms shall be initiated from the applicable inputs. If discrete inputs are not available, the specified alarms shall be initiated from the applicable analog input; alarm set points shall be operator adjustable.

D. PLC I/O Types

1. Regular Digital Input: Provide HMI display of state on display screens. Change of state sent to historical database file.

2. Alarmed Digital Input: Provide HMI display of state on display screens. Change of state sent to alarm history display and file, and alarm summary display.

3. Flowmeter Totalizer Pulse Digital Input: Provide HMI display of state, flow quantity total in thousands of gallons on display screens. Total shall be adjustable (not just reset to zero) on a Supervisor's Setpoint display screen.

a. Flowmeters shall have ethernet/IP connection. Flow totals can be read directly from the meter. Meters shall have three separate totalizers built-in, with one that is non-resettable, one that is user resettable, and one that is reset monthly by the program.

4. Motor Run Digital Input: Provide HMI display of state, accumulated total starts, and accumulated run time in tenths of hours on display screens. Both numbers shall be adjustable (not just reset to zero) on a Supervisor's Setpoint display screen.

5. Analog Input: Provide HMI display of scaled value on display screens. Provide HMI display adjustable setpoints for all scaling values. Only scaled value sent to historical database file and historical data/trending display screens.

6. Alarmed Analog Input: Provide HMI display of scaled value display screens, and the following four alarms; Low Low, Low, High, High High. Provide HMI display adjustable setpoints for all alarming values on a Supervisor's Setpoint display screen. Provide HMI display adjustable setpoints for all scaling values. Scaled value sent to historical database file and historical data/trending display screens. Adjustable setpoints time delayed Low Low, and High High alarms sent to alarm history display and file, and alarm summary display. PLC and HMI memory allocation shall allow at least four time delayed alarm setpoints for each Alarmed Analog Input or more as required.

7. Flowmeter Alarmed Analog Input: Provide HMI display of damped and scaled value next to the scaled only (not damped) value on display screens, and the following four alarms; Low Low, Low, High, High High. Provide HMI display adjustable setpoints for all alarming values on a Supervisor's Setpoint display screen. Provide HMI display adjustable setpoints for all scaling values. Only damped and scaled value sent to historical database file and historical data/trending display screens. Adjustable setpoints time delayed Low Low, and High High alarms sent to alarm history display and file, and alarm summary display. PLC and HMI memory allocation shall allow at least four time delayed alarm setpoints for each Alarmed Analog Input or more as required.

1.7 QUALITY ASSURANCE

A. The control strategies shall be tested as part of the factory and field acceptance tests and in accordance with the requirements specified in Section 40 91 00 – SCADA Systems and Equipment.

PART 2 -- PRODUCTS – NONE

PART 3 -- EXECUTION

3.1 PS-1 – WATER REUSE PUMP STATION

A. Description: The Water Reuse Pump Station returns water from the tailrace of the lower raceway and rearing pond to the flow distribution box at the upstream end of the facility. A local control panel (LCP) with a PLC to control the pump station functionality shall be located near to the pump station. Additionally, the individual pump run and alarm signals are to be sent to the facility's RTU to then be transmitted to the main hatchery control panel at the Bernie Kai Kai Gobin Hatchery.

1. There are two reuse pumps designated 5-P-1 and 5-P-2. Each pump with its own VFD. The pumps can be manually started, stopped, and their speed controlled by an operator at the LCP using its HMI and PLC. When in auto mode, the pumps will be automatically stopped due to low level by a float in the pump station wet well.

2. The reuse pumps shall operate in an alternating LEAD-LAG pump station control scheme. The two pumps shall alternate their LEAD-LAG status as programmed by the operator.

3. There shall be an adjustable LOW LOW- level float shut-off switch in the wetwell for each pump and wired directly into the VFD.

B. Local indications at each Reuse Pump VFD will be the manufacturer's standard including:

1. POWER AVAILABLE status.

2. RUNNING status.
3. STOPPED status.
4. MOTOR SPEED (RPM).
5. DRIVE ALARM.
6. MOTOR ALARM.
7. Elapsed time meter (ETM).
8. Operations counter (OC).

C. Local indications at the LCP include:

1. LCP POWER AVAILABLE indicating light (white).
2. LOW LOW WETWELL WATER LEVEL alarm light (yellow).
3. 480VAC PHASE LOSS/REVERSAL alarm light (yellow).
4. The LCP HMI will also display all the information listed above and status and alarm information for each Reuse Pump VFD.
5. The LCP HMI will also display for each Reuse Pump VFD that it is ready to run, it has been called to run by the PLC, the speed it is commanded to run.

D. PLC Inputs either Ethernet or hard-wired:

1. LCP POWER AVAILABLE.
2. Reuse Pump RUNNING status (each pump).
3. Reuse Pump MOTOR SPEED (each pump).
4. Reuse Pump DRIVE ALARM (each pump).
5. Reuse Pump MOTOR ALARM (each pump).
6. 480VAC PHASE LOSS/REVERSAL alarm status.

E. Local Manual Control Mode: Each pump can be controlled locally using its VFD operator interface controls when its HAND/OFF/REMOTE selector to the HAND mode. Each pump can be started, stopped and its speed controlled by the operator.

F. Local Automatic Control Mode:

G. Remote Automatic Control Mode: The following remote (PLC) automatic control mode functions shall be programmed:

1. If a running reuse system pump fails, the PLC shall signal an alarm and automatically start other reuse system pump.

2. The operator will control the pump station by programming the following setpoint values into the PLC based upon the water level in the wet well as reported by the level sensor or by setting the alarm floats as desired to trigger system alarms:

a. FILTRATION SYSTEM FLOW SETPOINT = Operator adjusted setpoint from sent from PLC to the VFD to adjust pump speed to maintain the setpoint.

b. LOW LOW LEVEL ALARM = Operator adjusted float set to stop both water reuse pumps and to transmit an alarm to the local control panel and to the main hatchery control panel.

c. REUSE PUMP MIN SPEED = Operator selected minimum pump speed (RPM).

d. REUSE PUMP MAX SPEED = Operator selected maximum pump speed (RPM).

e. REUSE PUMP STARTING PUMP = Operator selected pump to be the first one restarted after a complete shutdown or power loss (Pump P-1 or Pump P-2).

f. REUSE PUMP ALTERNATING DOW TIME = Operator selected day of the week (DOW) and time of day to trigger alternating the pumps.

g. REUSE PUMP RESTART DELAY = Supervisor selected time delay between starting any pump after any other pump was started to prevent overloading the electrical system (seconds).

3. Alternation of Pumps: The PLC will automatically select alternate weekly on the day of the week and time selected by the operator.

3.2 PS-2 – TRENCH DRAIN PUMP STATION

A. Description: The Trench Drain Pump Station transfers water to the clarifier from the collection channel located at the downstream end of the lower raceways and rearing pond. The two trench drain pumps, 5-P-3 and 5-P-4, shall each be supplied with FVNR starters in a duplex Vendor Control Panel (VCP). The pumps shall be manually started and stopped by the operator using START/STOP latching pushbuttons or rotating selector switches in the VCP. The program shall also be able to operate on a timer. Run and alarm status of the pumps shall be transmitted to the RTU. The pump station shall transmit alarms to the VCP and RTU. Both pumps can be run at the same time as needed.

B. Local indications include:

1. POWER AVAILABLE indicating light (white).
2. RUNNING indicating light for each pump (green).
3. STOPPED indicating light for each pump (red).
4. TRIPPED (motor starter overload) indicating light for each pump (yellow).
5. Elapsed time meter (ETM) for each pump.
6. Operations counter (OC) for each pump.
7. [Note the phase loss/reversal relay does not have an indicating light on the door of the VCP] (hard-wired shutdown).

C. Local Manual Control Mode: Local manual control for each pump is performed by rotating the selector switch to the pump ON position at the VCP to start the pump. The pump is stopped by rotating the selector switch to the pump OFF position at the VCP to stop the pump. The pump may be run for an operator adjustable time duration by rotating the selector switch to TIMER position. The switch will spring back to off after the timer starts. A light will indicate when the pump is running for the duration of the timer.

D. Local Automatic Control Mode: There are no automatic controls for the trench drain pumps.

E. Remote Manual Control Mode: There are no remote manual controls for the trench drain pumps.

F. Remote Automatic Control Mode: There are no remote automatic controls for the pumps.

3.3 PS-3 – SPAWNING WASTE PUMP STATION

A. Description: The Spawning Waste Pump Station transfers water to the clarifier from the carcass channel drain and from the lower raceways and rearing pond deck drains located at the upstream end of the lower raceways and rearing pond. The two spawning waste pumps, 6-P-1 and 6-P-2, shall each be supplied with FVNR starters in a duplex Vendor Control Panel (VCP). The pumps shall be manually started and stopped by the operator using START/STOP latching pushbuttons or rotating selector switches in the VCP to run in AUTO. Run and alarm status of the pumps shall be transmitted to the RTU. The pump station shall have adjustable float switches to transmit alarms to the VCP and RTU. Both pumps can be run at the same time as needed. A high high water level alarm will trigger both pumps to run until the water level reaches the low shut-off alarm, at which point, both pumps will shut off. The Spawning Waste Pumps shall operate in an alternating LEAD-LAG pump station control scheme. The two pumps shall alternate their LEAD-LAG status.

B. Local indications include:

1. POWER AVAILABLE indicating light (white).
2. RUNNING indicating light for each pump (green).
3. STOPPED indicating light for each pump (red).
4. TRIPPED (motor starter overload) indicating light for each pump (yellow).
5. HIGH HIGH WATER LEVEL alarm light (yellow) (hard-wired start both pumps).
6. Elapsed time meter (ETM) for each pump.
7. Operations counter (OC) for each pump.
8. [Note the phase loss/reversal relay does not have an indicating light on the door of the VCP] (hard-wired shutdown).

C. Local Manual Control Mode: Local manual control for each pump is performed by either pressing the pump start latching pushbutton or rotating the selector switch to the pump ON position at the VCP to start the pump. The pump is stopped by either pressing the pump stop latching pushbutton or rotating the selector switch to the pump OFF position at the VCP to stop the pump.

D. Local Automatic Control Mode: Automatic Control Mode will utilize float switches to turn on a pump at a preset high water level and both pumps at a preset high high water level. and to turn off the pumps at a preset low low water level.

E. Remote Manual Control Mode: There are no remote manual controls for the spawning waste pumps.

F. Remote Automatic Control Mode: There are no remote automatic controls for the pumps.

G. HIGH HIGH-LEVEL ALARM = Operated adjusted float set to transmit an alarm to the VCP and to the main hatchery control panel.

H. LOW LOW-LEVEL ALARM = Operator adjusted float set to stopboth spawning waste pumps and to transmit an alarm to the VCP and to the main hatchery control panel.

3.4 PS-4 – UTILITY WATER AND TRUCK FILL PUMP STATION

A. Description: The Utility Water Pump (3-P-1) and Truck Fill Pump (3-P-2) are located in the Distribution box and supply water to the sprinkler and washdown systems in the intermediate and lower raceways and rearing pond areas of the facility and to the truck fill station. The pumps are not interconnected in their operations and each shall be supplied with FVNR starters in a simplex Vendor Control Panel (VCP). The pumps shall be manually started and stopped by the operator using START/STOP latching pushbuttons or rotating selector switches in the VCP. Run and alarm status of the pumps shall be transmitted to the RTU.

B. Local indications include:

1. POWER AVAILABLE indicating light (white).
2. RUNNING indicating light for each pump (green).
3. STOPPED indicating light for each pump (red).
4. TRIPPED (motor starter overload) indicating light for each pump (yellow).
5. LOW WATER LEVEL ALARM alarm light (red) and pumps off.
6. Note the phase loss/reversal relay (hard-wired shutdown) does not have an indicating light on the door of the VCP.

C. Local Manual Control Mode: Local manual control for each pump is performed by either pressing the pump start latching pushbutton or rotating the selector switch to the pump ON position at the VCP to start the pump. The pump is stopped by either pressing the pump stop latching pushbutton or rotating the selector switch to the pump OFF position at the VCP to stop the pump.

D. Local Automatic Control Mode: Local automatic control for each pump is performed by either pressing the AUTO TIMER ON momentary pushbutton or rotating the selector switch to the AUTO TIMER ON position at the VCP to start the pump. The pump will shut off after a 1-hour timed delay.

E. Remote Manual Control Mode: There will be remote manual controls for the Truck Fill pump. The remote manual controls for the truck fill pump is performed by pressing the ON pushbutton. The pump is stopped by pressing the OFF pushbutton.

F. Remote Automatic Control Mode: There are no remote automatic controls for the pumps.

G. LOW LOW LEVEL ALARM = Operator adjusted float set to stop both pumps and to transmit an alarm to the VCP and to the main hatchery control panel.

3.5 FILTER

A. Description: The screen filter assembly will consist of three 40-micron screen filters connected by a common manifold. Each filter will have a manual butterfly valve on the inlet an outlet pipe, and a bypass pipe with a manual butterfly valve on the common

manifold in the event all three screen filters are offline. The screen filters are designed to operate as duty/standby with two screens operating at a time and one on standby. The screen filters act as primary filtration for effluent pumped from the tailrace of the lower pond to remove fish waste.

The screen filter features an automatic backwash system that triggers on differential build-up across the screens. Measurement of the difference in water levels between the front and the back of the screen determines the degree of contamination and initiates the cleaning of the screen. When triggered, a suction nozzle opens that pulls material off the screen. The backwash is driven by pressure difference through the suction nozzle and a separate pump is not required for backwash. Backwash from the screen filter is directed to the clarifier.

B. Control Functions:

1. The pressure upstream of the filter is monitored in the PLC by a pressure gage and transmitter.

2. Screen filters operate (HAND/OFF/AUTO) based on differential pressure measured within the unit.

3. System control is dictated by the flush port pressure gauge, the inlet pressure gauge, and the backwash control

   a. A flush valve opens automatically that creates a low-pressure path for suction nozzles to vacuum debris from the screen – pressure at the flush port should be minimized.

   b. Backwash is automatic based on differential but can be set to a timer if desired at the LCP.

4. The cleaning cycle for each intake may be initiated remotely by the PLC when the screen filters are in HAND mode.

5. A back-pressure sustaining valve downstream of the screen filter pressure is modulated to maintain system pressure at or above a minimum pressure set point as measured by the pressure gage.

6. Each screen filter provides running status (on/off) and failure alert back to the plant PLC.

3.6 UV DISINFECTION

A. Description: Each of the UV units are pre-packaged units supplied by a UV vendor and includes the UV reactors, UV electrical control panel, and UV sensors. Each UV unit is sized to handle 1,250gpm.

Each lamp bank is equipped with a UV intensity sensor. The UV intensity sensor is used to measure the UV intensity, which is displayed at the local control panel provided by the UV vendor, and on the SCADA system. This measured UV intensity is not used for control but used to generate a Low UV Intensity alarm at the local control panel when the measured UV intensity drops 25% (adjustable) below the theoretical UV intensity calculated by the controller.

The control panel includes a local PLC which controls the operation of the UV system. During normal operation the output of the UV vessel is varied to meet the Operator adjustable UV dosage setpoint (designed to be set at 60 mJ/cm^2).

Under normal operating conditions the two vessels are operating simultaneously. The power level of each bank is varied by the system, between 50 to 100% power to maintain the pre-set UV dosage.

When one of the units is required to be shut down for maintenance, the operator can request which UV vessel to be shut down from the PLC. Butterfly valves are in place on the inlets and outlets of each UV unit to prevent water from bypassing through the off UV unit while shut down.

The performance (Flow rate and UV dose) of the UV system shall be monitored and displayed on main plant PLC.

Similar to the other vendor supplied package, the Plant main PLC will monitor the performance and status of the UV system. If the Plant main PLC wants to take control the operation of the equipment, the appropriate digital signals and analogue speed control signals need to be wired to each machine.

Alarms will be generated at the local control panel, plant main PLC, and at the SCADA level during the situation of no flow, high temperature, unit failure, lamps broken and so on.

B. Control Functions:

1. The total system flow shall be provided to the UV control panels to allow for UV dose pacing. With UV dose pacing, the lamp power will automatically dim down to 50% to reduce power consumption. Dimming is when the UV system automatically regulates its power level to not deliver a higher UV dose than necessary through input from the flow meter and the built-in UV intensity sensor.

    a. Alarms: Temperature sensors are included with the UV lamp banks and will shut the UV lamps off if temperature reads too high. Leakage alarm.

3.7 Oxygen Generation System

A. Description: The on-site Oxygen generation equipment will be installed inside a dedicated shipping container.

Refer to the vendor's user / O&M manual for a full, detailed description of the packaged oxygen generation system and its components.

Per the vendor's O&M manual for system control, the pressure setting shall be used to monitor and operate the Generators and/or ramp up the VFD on each of the Generators.

There is a turndown setting. The ON and OFF pressures can be set. The oxygen generators skid has a pressure tank that stores the excess product. The machine will stop at the OFF pressure and turn on at the ON pressure. There is no need to slow down the generator output.

The vendor control panel has an EtherNet/IP communications, which allows for monitoring of all operational and monitoring statuses and control setpoints available from the vendor's

input/output taglist (available from the vendor) on the SCADA system. Additionally, operations can use VNC Viewer to monitor and control the oxygen generator remotely (logging into the vendor's local HMI screen), but the project's recommendation is to populate SCADA with the relevant monitoring and controls data to provide a reliable monitoring and control system.

In addition to the Ethernet connection between the vendor control panels and the PRAS control network, hardwired signals have been provisioned for to allow for redundant hardwired monitoring and control of the oxygen generators. A hardwired ENABLE/DISABLE allows for Operations to remote manually permit or prohibit the oxygen generator system from running from SCADA. Additionally, the oxygen generator is monitored for on/off status, low purity status alarm, and system trouble (general fault) status for annunciation on SCADA.

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SECTION 40 91 00 - SCADA SYSTEMS AND EQUIPMENT

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide supervisory control and data acquisition (SCADA) system equipment, support, and programming. Work under this contract shall include the following:

1. Provide a single Remote Terminal Unit (RTU) panel (RTP-LP), located in the spawning shed next to the electrical panels.

2. In addition to the local control panels and local readouts for the instrumentation devices described elsewhere in the specifications, a run and alarm signal from each pump in each pump station and the data obtained from the various instruments (flow, level, D.O., etc.) shall be connected to the RTU panel.

3. The connection between the RTU and the pump station local control panels and the instrumentation devices shall be completed using armored fiber cables pulled through new conduit.

4. Procure and install a cellular telemetry unit or equivalent panel to transmit all signals and alarms back to the Owner's main hatchery control panel located at the Bernie Kai Kai Gobin Hatchery in Tulalip, WA.

5. Program the main hatchery panel to integrate all signals and alarms from the Tulalip Lower Pond Hatchery facility into the Owner's current hatchery monitoring system.

B. Responsibilities

1. The CONTRACTOR, through the use of a single System Integrator and qualified electrical and mechanical installers, shall be responsible to the OWNER for the implementation of the SCADA system upgrades and the integration with other required instrumentation and control devices.

2. Due to the complexities associated with the interfacing of numerous control system devices, it is the intent of these specifications that the System Integrator will be responsible to the CONTRACTOR for the integration of the SCADA system with existing devices and devices provided under this and other Divisions with the objective of providing a completely integrated control system free of signal incompatibilities.

3. The CONTRACTOR shall request the OWNER to demonstrate that all existing equipment that is to be reused or interfaced with in this project works properly for the intended function. In the event the existing equipment does not work, the issue should be brought up in preconstruction/ pre-submittal meeting(s).

4. At a minimum, the implementation of the SCADA system upgrades by the CONTRACTOR shall include the following WORK:

a. Integrate the existing devices and systems provided under this and other Divisions with the existing hatchery SCADA system.

b. Prepare the required submittals

c. Design and develop project-wide loop/schematic diagrams including those associated with equipment provided under other Divisions and Owner-furnished and existing equipment

d. Design and develop control panel drawings

e. Field verify existing conditions

f. Procure hardware and software

g. Configure and factory test the equipment

h. Verify instrument calibration after installation

i. Terminate signals inside control and network panels; terminate communication and network devices and nodes

j. Coordinate installation and termination of field signals, power, and utilities associated with the SCADA system upgrades. Resolve signal, power, or functional incompatibilities between new and existing interfacing devices.

k. Oversee, document, and certify system commissioning including setpoints.

l. Prepare technical manuals

m. Prepare SCADA system as-built final construction drawings

C. RELATED WORK AND REQUIREMENTS SPECIFIED ELSEWHERE

1. All electrical work required under this section shall conform to the requirements of this Section and the applicable requirements of the Sections in Division 01 and Division 26.

1.2 DEFINITIONS

A. System Integrator**:** The System Integrator shall be a single firm, corporation, or other entity assuming full responsibility through the CONTRACTOR to perform all engineering and to select, furnish, program, configure, integrate, supervise the installation and connections, test, calibrate, and place into operation all instrumentation, controls, communication hardware and software. The System Integrator shall specialize and have an experienced engineering and technical staff in the design, integration, and supply of systems similar to the one in these Contract Documents.

1. Acceptable System Integrators, or approved equal:

a. L2 Systems, LLC. (Contact: Glen Lee 360-386-9675, glen.lee@l2systemsllc.com)

1.3 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 - Submittal Procedures and the requirements below. The CONTRACTOR shall coordinate the SCADA system updates

part of the WORK so that a complete instrumentation and control system will be provided and will be supported by accurate Shop Drawings and as-built drawings. Interface between instruments, flowmeters and other equipment related to the SCADA system shall be included in the shop drawing submittal. Interface between existing equipment, instruments and control panels shall also be included.

B. Shop Drawings: Provide shop drawings showing interfaces between new and existing instruments, flow meters, panels, and other equipment related to the SCADA system.

C. System Hardware: Provide a technical data sheet or brochure for each hardware component.

D. System Software: Submit vendor documentation including description of the standard (baseline) application Human Machine Interface (HMI) software programs, operating system and utility programs to be furnished. In addition, provide control narratives which describe all monitoring and control functions in the PLC.

E. Input and Output (I/O) Data List: Provide I/O data base listing for each data point relevant parameters such as range, active state, contact orientation, limits, incremental limits, and I/O hardware address.

F. Panel Drawings: Provide panel drawings for each new panel.

G. Technical Manual: Provide technical manuals for all furnished equipment.

1.4 WARRANTY

A. Parts and materials shall be warranted for defects for a period of 1-year after the date of installation.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Standard and Current Technology: All SCADA system hardware, software, materials, and equipment furnished under this contract shall be new, free from defects, and shall be standard products and technology produced by manufacturers regularly engaged in the manufacturer of these products. Meters, instruments, and other components shall be the most recent field-proven models marketed by their manufacturers at the time of submittal of the Shop Drawings unless otherwise required to match existing equipment.

B. Instrument and Loop Power: Power requirements and input/output connections for components shall be verified. Power for transmitted signals shall, in general, originate in and be supplied by the control panel devices. Power supplies shall be mounted within control panels or in the field at the point of application.

C. Loop Isolators and Converters: The CONTRACTOR is responsible to resolve any signal level incompatibilities where required.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. General

1. All systems and instrumentation, including instrumentation furnished under other Divisions, shall be installed, connected calibrated, tested, started, and placed into operation in accordance with CONTRACT documents under Division 40 and the manufacturers' instructions. The installation shall be coordinated with the ENGINEER. This shall include final integration in concert with equipment specified and provided by others.

2. The CONTRACTOR shall employ installers who are skilled and experienced in the installation and connection of all equipment.

3. The CONTRACTOR shall review the existing site conditions and examine all shop drawings for the various items of equipment in order to determine exact routing and final terminations for all wiring and cables.

4. The Contract Documents identify conduits and instruments required to make a complete SCADA system. The CONTRACTOR shall be responsible for providing any reasonable additional or different type connections as required by parts of the SCADA system specific installation requirements, or as practical.

B. Installation and Connections:

1. Instruments, control panels, and equipment shall be anchored by methods that comply with seismic requirements applicable to the Site. Appropriate mounting stands and bracket materials and workmanship shall be provided and shall comply with requirements of the Contract Documents.

2. Wires and cables shall be arranged in a neat manner and securely supported in cable groups and connected from terminal to terminal without splices unless specifically approved by the ENGINEER. Wiring shall be protected from sharp edges and corners.

3. Connectors shall be, as a minimum, water tight where below grade.

3.2 COMMISSIONING

A. Commissioning is the verification that the complete WORK functions on an extended basis and is in full conformance with the Contract requirements. Provide commissioning of the SCADA system and equipment that demonstrates continuous successful function for a period of at least 7 days.

END OF SECTION

SECTION 40 91 02 – IN-LINE LIQUID FLOW MEASURING

PART 1 -- GENERAL

1.1 THE SUMMARY

A. General: The CONTRACTOR shall provide in-line liquid flow measuring systems, complete and operable, in accordance with the Contract Documents.

B. Provide magnetic or ultrasonic flow measuring systems best suited for the proposed installation locations.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. The requirements of Division 26 – Electrical shall apply to this specification.

B. The requirements of Specification Section 40 91 00 – SCADA Systems and Equipment shall apply to this section.

1.3 SUBMITTALS

A. Provide product submittals in accordance with the requirements of Section 01 33 00 – Submittal Procedures. Submittal information shall show compliance with the requirements of this section.

PART 2 -- PRODUCTS

2.1 MULTI-POINT ELECTROMAGENTIC FLOW MEASURING SYSTEMS

A. Manufacturers: The Magnetic flow meter manufacturer and model flow meters shall be as follows or equal:

1. **Flow-Tronic Torpee-Mag**

B. Description: Multi-point electromagnetic flow meters shall be insertion type that uses electromagnetic induction to determine a voltage that is directly proportional to the velocity of the liquid flow rate.

C. Performance / Design Criteria: Magnetic flowmeter system shall be suitable for the intended service and shall be based on the conductivity properties and solid content of the process fluid, in accordance with the manufacturer's recommendations.

1. Electromagnetic flowmeter system shall be capable of measuring fluid velocities in the range of 0 and 19.68 ft. /sec. in both forward and reverse flow in all sensor sizes.

2. Accuracy: The flow metering system shall be installed in accordance with the manufacturer's recommendations to provide at least 0.5 percent of flow rate from 0.82 ft. /sec. to 100 percent full scale for velocities.

3. Repeatability: 0.2 percent of reading.

4. Power input shall be 12 to 48-volt DC.

D. Materials / Components: The flow metering system shall include a multi-electrode sensor, transmitter, signal cable, and converter.

1. Multi-Electrode Sensor:

a. The electrode sensor shall be 316 stainless steel and available in lengths from at least 1.5-inches to 48-inches.

b. A minimum of two (2) electrodes shall be provided. The electrodes' material shall be suitable for the required service as recommended by the manufacturer. A reference electrode shall be provided as recommended by the manufacturer for the required installation application.

c. Meter shall be rated for NEMA 6P (IP68) (limited depth). It shall be able to operate between -20 to 140 Degrees F (-29 to 60 degrees C).

2. Transmitter/Converter

a. The transmitter/converter shall be capable of being mounted integral to the metering tube or remotely. Mounting hardware shall be provided.

b. The transmitter/converter shall be rated for NEMA 6 (IP67). It shall be able to operate in ambient temperatures of -4 to 140 degrees F (-20 to 60 degrees C).

c. The transmitter shall convert the DC pulse signal from the metering tube to a data signal.

d. The transmitter shall have an LCD displays for flow rate, percent of span, totalization, operator configuration interface, and diagnostic information.

e. The transmitter shall have an adjustable integral low flow cutoff and zero return.

f. The transmitter shall perform self-diagnostics and automatic data checking and activate a switch closure output when a transmitter fault is detected.

g. The transmitter shall support Ethernet/IP communication for compatibility with the OWNER's hatchery monitoring and alarm system.

h. In addition to the local display, the flow meter data shall be routed to the RTU panel via armored fiber cable in new conduit for subsequent transmission to the Owner's main hatchery control panel located at the Bernie Kai Kai Gobin Hatchery near Marysville, WA.

3. Cables

a. Remote transmitter configuration shall be provided with the required lengths and types of electrodes and coil drive cables as recommended by the manufacturer for the required installation application. Maximum distance of transmitter from the metering tube shall be as recommended by the manufacturer.

b. Calibration: Each flow metering system shall be hydraulically calibrated at a facility that is traceable to the National Institute of Standards and Technologies. The calibration procedure shall conform to the requirements of ANSI/NCSL Z 540-1 Calibration. A real-time computer-generated printout of the actual

calibration data shall be submitted to the ENGINEER at least 30 Days prior to shipment to the site.

2.2 MAGNETIC FLOW MEASURING SYSTEMS

A. Manufacturers: The Magnetic flow meter manufacturer and model flow meters shall be as follows or equal:

1. **Endress+Hauser Promag 400W**

B. Description: Magnetic flowmeter systems shall be the low frequency electromagnetic induction type that produces a DC pulsed signal directly proportional to and linear with the liquid flow rate.

C. Performance / Design Criteria: Magnetic flowmeter system shall be suitable for the intended service and shall be based on the conductivity properties and solid content of the process fluid, in accordance with the manufacturer's recommendations.

1. Magnetic flowmeter system shall be capable of measuring fluid velocities in the range of 0.04 and 33 ft. /sec. in both forward and reverse flow in all sensor sizes.

2. Accuracy: The flow metering system shall be installed in accordance with the manufacturer's recommendations to provide at least 0.5 percent of flow rate from 10 to 100 percent full scale for velocities over 3 feet per second.

3. Repeatability: 0.1 percent of reading.

4. Power input shall be 24-volt DC.

D. Materials / Components: The magnetic flow metering system shall include a metering tube, transmitter, and signal cable and flowmeter grounding rings.

1. Metering Sensor/Tube:

a. The metering sensor shall employ a pulsed DC technique to drive flux-producing coils. Sensors using high pulsed DC signals shall be used in accordance with the manufacturer's recommendations for the required service application.

b. The metering tube sizes shall be available from at least 1-inch to 48-inch line size. It shall be sized in accordance with the installation application and the intended service and as recommended by the manufacturer. If fractional size or larger size meters are required, the manufacturer shall be consulted for availability.

c. Metering Sensor/Tube

1) Flanged Connections: The flanges' size, style, type and construction material shall be in accordance with the required installation and the intended service application and as recommended by the manufacturer. Pressure ratings shall match the piping in accordance with the requirements of Section 40 05 00 – Piping, General as recommended by the manufacturer for the intended service.

2) A minimum of two (2) electrodes shall be provided. The electrodes' material shall be suitable for the required service as recommended by the manufacturer. A reference electrode shall be provided as recommended by the manufacturer for the required installation application.

3) Lining material shall be in accordance with the manufacturer's recommendation for the intended service.

4) Meter housing shall be rated for NEMA 6P (IP68) (limited depth). It shall be able to operate between -20 to 140 Degrees F (-29 to 60 degrees C).

5) Meter tube shall have epoxy protective coating.

6) Grounding rings shall be provided and designed to protect and shield the liner's edge interface from abrasion at the meter end. Grounding rings shall conform to the manufacturer's bore and material recommendation for the intended service Grounding shall conform to the manufacturer's recommendations.

2. Transmitter/Converter

a. The transmitter/converter shall be capable of being mounted integral to the metering tube or remotely. Mounting hardware shall be provided.

b. The transmitter/converter shall be rated for NEMA 4X (IP67). It shall be able to operate in ambient temperatures of -20 to 140 degrees F (-29 to 60 degrees C).

c. The transmitter shall convert the DC pulse signal from the metering tube to a data signal.

d. The transmitter shall have an LCD displays for flow rate, percent of span, totalization, operator configuration interface, and diagnostic information.

e. The transmitter shall have an adjustable integral low flow cutoff and zero return.

f. The transmitter shall perform self-diagnostics and automatic data checking and activate a switch closure output when a transmitter fault is detected.

g. The transmitter shall support Ethernet/IP communication for compatibility with the OWNER's hatchery monitoring and alarm system.

h. In addition to the local display, the flow meter data shall be routed to the RTU panel via armored fiber cable in new conduit for subsequent transmission to the Owner's main hatchery control panel located at the Bernie Kai Kai Gobin Hatchery near Marysville, WA.

3. Cables

a. Remote transmitter configuration shall be provided with the required lengths and types of electrodes and coil drive cables as recommended by the manufacturer for the required installation application. Maximum distance of transmitter from the metering tube shall be as recommended by the manufacturer.

E. Calibration: Each flow metering system shall be hydraulically calibrated at a facility that is traceable to the National Institute of Standards and Technologies. The calibration procedure shall conform to the requirements of ANSI/NCSL Z 540-1 Calibration. A real-time computer-generated printout of the actual calibration data shall be submitted to the ENGINEER at least 30 Days prior to shipment to the site.

PART 3 -- EXECUTION

3.1 FIELD QUALITY CONTROL

A. In-line liquid flow measuring systems shall be handled, installed, calibrated, loop-tested, pre-commissioned, and performance tested in accordance with manufacturer's recommendations.

END OF SECTION

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SECTION 40 91 06 - LEVEL MEASURING

PART 1 -- GENERAL

1.1 THE SUMMARY

A. General: The CONTRACTOR shall provide level measuring systems, complete and operable in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. The requirements of Division 26 – Electrical shall apply to this specification.

B. The requirements of Specification Section 40 90 10 – Control Strategies shall apply to this section.

C. The requirements of Specification Section 40 91 00 – SCADA Systems and Equipment shall apply to this section.

1.3 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

A. Submittals shall be provided in accordance with the requirements specified in Sections 01 33 00 – Contractor Submittals and 40 91 00 – SCADA Systems and Equipment.

PART 2 -- PRODUCTS

2.1 NON-CONTACT ULTRASONIC TYPE LEVEL MEASUREMENT

A. Manufacturers: Ultrasonic level measuring systems shall be **Siemens Hydroranger series, Endress + Hauser,** or equal.

B. Description: Ultrasonic level measuring systems shall use continuous ultrasonic echo ranging technology to monitor liquid level of any consistency consist of an electronic controller-transmitter, a non-contact ultrasonic transducer, and interconnecting cables. The controller-transmitter shall generate the ultrasonic signal to drive the transducer, detect the return echo and convert the elapsed time to a level signal.

C. Performance / Design Criteria:

1. The level sensor shall include a local display panel.

2. The transmitter unit shall provide an isolated 4 - 20 mADC output signal, linearly proportional to level. The output shall be compatible with HART protocol. The transmitter shall have a single or a dual point level monitoring. In addition, the transmitter shall provide up to six (6) SPDT relay outputs, rated at 5Amp.

3. The transmitter's accuracy shall be at least 0.25-percent of span. It shall have non-interacting zero and span controls. The unit shall have a local LCD display for configuration and monitoring scalable in the desired process variable. Measuring range shall exceeed the available water elevation range including abnormal operations.

4. The transmitter shall support Ethernet/IP communication for compatibility with the OWNER's hatchery monitoring and alarm system.

5. In addition to the local display, the level sensor data shall be routed to the RTU panel via armored fiber cable in new conduit for subsequent transmission to the OWNER's main hatchery control panel located at the Bernie Kai Kai Gobin Hatchery near Marysville, WA.

D. Materials/Components: Transducer shall have temperature compensation and a contact output upon transmitter failure (loss of echo). Input power shall be 24 volt DC. The ultrasonic transducer shall be housed in an enclosure suitable for the required installation location.

PART 3 -- EXECUTION

3.1 FIELD QUALITY CONTROL

A. Level measuring systems shall be handled, installed, calibrated, loop-tested, pre-commissioned, and performance tested in accordance with Section 40 91 00 - SCADA Systems and Equipment. Manufacturer's service, supervision, and training shall also be in accordance with Section 40 91 00 - SCADA Systems and Equipment.

END OF SECTION

SECTION 40 91 08 - PRESSURE MEASURING

PART 1 -- GENERAL

1.1 THE SUMMARY

A. General: The CONTRACTOR shall provide pressure measuring systems, complete and operable, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. The requirements of Division 26 – Electrical shall apply to this specification.

B. The requirements of Specification Section 40 90 10 – Control Strategies shall apply to this section.

C. The requirements of Specification Section 40 91 00 – SCADA Systems and Equipment shall apply to this section.

1.3 ACTION SUBMITTALS / INFORMATIVE SUBMITTALS

A. Submittals shall be provided in accordance with the requirements specified in Section 01 33 00 – Contractor Submittals and Section 40 91 00 – SCADA Systems and Equipment.

PART 2 -- PRODUCTS

2.1 PRESSURE GAUGES

A. Manufacturers: Shall be **Ashcroft 1279, Ametek Solfrunt Series 1900**, or Equal.

B. Performance/Design Criteria: Gauge Protection: Gauges shall be protected with the appropriate components as indicated.

C. Materials/Components:

1. Pressure gauges shall be 4-1/2 inches, with white laminated dials and black graduations, and have either a shatterproof glass or acrylic window as indicated in the data sheet. The gauges' bottom connection size shall be as indicated.

2. Sensing element shall be bourdon tube with welded, stress-relieved joints. Sensing element material shall be as recommended by the manufacturer. Gauges shall have an accuracy of plus and minus 1/2-percent of full scale.

3. Body material shall be as recommended by the manufacturer.

4. Gauge shall be either dry or liquid-filled as indicated.

5. Gauges shall be provided with a 316 stainless steel pulsation dampener (snubber). The pulsating dampener shall absorb system pressure pulses.

2.2 DIAPHRAGM SEALS FOR PRESSURE MEASURING SYSTEMS

A. Description: Operating Principles The diaphragm seal shall attach to the inlet connection of a pressure instrument in order to isolate its measuring element from the process fluid due to incompatibility and/or high process fluid temperature. The space between the diaphragm and the pressure element shall be completely filled with a suitable liquid. Displacement of the liquid fill in the pressure element through the movement of the diaphragm shall transmit process pressure changes directly to a gauge, transmitter, switch, or other pressure instrument.

B. Materials/Components:

1. Diaphragm seals shall consist of bottom housing, lower ring, diaphragm capsule, fill screw, flushing connection, and a top housing.

2. The bottom housing shall be removable in order to permit servicing. Bottom housing material shall be compatible with the process liquid as recommended by the manufacturer and as indicated in the data sheet.

3. As a minimum, top housing and bolts shall be 316 stainless steel, or as recommended by the manufacturer for the intended service and installation application and as indicated in the data sheet.

4. Diaphragm capsule material shall be compatible with the process liquid as recommended by the manufacturer and as indicated in the data sheet.

5. The diaphragm seal shall be factory-assemble to the corresponding pressure instrument and factory-filled. The space between the diaphragm and the pressure element shall be completely filled with a suitable liquid as recommended by the manufacturer for the intended service and installation application and as indicated in the data sheet.

6. Material of exposed surfaces, housings, and diaphragm shall be as recommended by the manufacturer for the intended service and installation application and as indicated in the data sheet.

7. The seal shall be provided with a ring, flushing port connection, and fill/bleed connection.

8. The diaphragm seal shall be shipped a tag reading "Do not disassemble for installation”.

PART 3 -- EXECUTION

3.1 FIELD QUALITY CONTROL

A. Pressure measuring systems shall be handled, installed, calibrated, loop-tested, pre-commissioned, and performance tested in accordance with Section 40 91 00 SCADA Systems and Equipment.

END OF SECTION

SECTION 40 91 12 - PROCESS MONITORING

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. General: The CONTRACTOR shall provide all process monitoring systems, complete and operable, in accordance with the Contract Documents.

1.2 RELATED WORK AND REQUIREMENTS SPECIFIED ELSEWHERE

A. The requirements of Specification Section 01 33 00 – Contractor Submittals shall apply to this section.

B. The requirements of Division 26 – Electrical shall apply to this specification.

C. The requirements of Specification Section 40 90 10 – Control Strategies shall apply to this section.

D. The requirements of Specification Section 40 91 00 – SCADA Systems and Equipment shall apply to this section.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Power Requirements: Power Input to the analyzer or controller shall be 120V, AC. Controllers using other than 120VAC power shall be provided with a power supply using 120VAC power input.

B. Ambient Conditions: Analyzers shall be suitable for continuous automatic on-line analysis of the parameter specified for each analyzer under the conditions indicated.

1. The analyzer shall operate satisfactorily in ambient temperatures between -20 and 120 °F or shall be provided with an isothermal enclosure so that the specified accuracy is not impaired. Relative humidity shall be from 5 to 95 percent, non-condensing. The analyzer shall be rated for outdoor locations and provided with any accessories needed for outdoor mounting (drip shield, sun shield, etc.).

2. Process fluid temperatures will range between 40 and 100 °F.

C. The interconnecting cable between the sensor and the analyzer/controller/transmitter shall be either integral with the sensor or furnished by the instrument manufacturer and shall be of sufficient length to allow proper installation of the analyzer.

D. The analyzers and sensors shall be provided with all the necessary mounting and connation hardware suitable for the intended installation application.

E. Single manufacturer: All components of analyzers measuring the same parameter shall be products of a single manufacturer.

2.2 DISSOLVED OXYGEN MEASURING SYSTEM (MEMBRANELESS)

A. The dissolved oxygen analyze measuring system shall continuously monitor, indicate, and transmit the concentration of dissolved oxygen in an aqueous solution. The dissolved oxygen measuring system shall use an optical and/or luminescent sensor technology for continuous measurement of dissolved oxygen, independent of water temperature or air pressure.

B. The DO measuring system shall consist of a sensor and an analyzer/controller/transmitter.

C. Sensor

1. The sensor shall be an optical type that enables the oxygen from the sample to diffuse into the sensor's fluorescence or luminescence coating, which in turn responds to the sensor's LED light. The fluorescence intensity reduction is proportional to the DO concentration in the sample. The sensor shall have no membrane or electrodes to replace and shall not require filling solutions. The sensor shall be automatically temperature compensated.

2. The measurement shall be performed using a sensor that is immersed in the process.

3. Performance and Features:

   a. Measurement range shall be 0-20 ppm.

   b. The sensor shall have an accuracy of ±0.1 ppm between a range of 0-5 ppm and +/- 0.2 ppm for ranges above 5 ppm. Resolution shall be 0.01 ppm.

D. Analyzer Controller/Transmitter

1. The analyzer system shall be provided with a controller/transmitter unit that shall accept and process the input from minimum two (2) digital analyzers/sensors to produce the required output(s).

2. The controller shall use a menu-driven operation system and an auto-ranging digital alphanumeric display. The controller shall have at least two user security levels.

3. Analyzer system enclosure shall be mounted within a locking NEMA 4X enclosure mounted on a stainless-steel strut channel stand. The analyzer system enclosure shall be rated for the intended installation application.

4. Controller Output:

   a. For each analyzer/sensor the controller shall generate an isolated 4-20 mA DC linearly proportional to the calibrated range and capable of driving 600 ohms load.

   b. A minimum of three programmable SPDT relay outputs shall be provided for user-configurable functions. Contact ratings shall be 120VAC or 30 VDC 5 amps.

   c. The controller shall supper Ethernet/IP digital communication for compatibility with the OWNER's hatchery monitoring and alarm system.

d. In addition to a local display capability, the dissolved oxygen data shall be routed to the RTU panel via armored fiber cable in new conduit for subsequent transmission to the OWNER's main hatchery control panel located at the Bernie Kai Kai Gobin Hatchery near Marysville, WA.

E. Equipment mounting and support:

1. Provide a mounting assembly for the oxygen sensors (each location) and transmitter. Provide manufacturer standard mounting equipment for sensor, such as a universal holder and chain assembly compatible with equipment. Install sensor mounting equipment to hand railing or, where hand railing not available, provide an upright post system fabricated from strut or railing material and anchored to the top of the concrete wall.

F. Dissolved oxygen measuring system shall be **Endress+Hauser Oxymax COS61D sensor with Endress+Hauser Liquiline CM442 multiparameter transmitter** or equal.

PART 3 -- EXECUTION

3.1 GENERAL

A. Install DO sensors and transmitter to equipment mounting and supports. Contractor shall provide all components for a complete and functioning system. Sensor cables connecting to the transmitter shall be installed above grade in watertight conduit. Signal connection from the transmitter to the hatchery monitoring and alarm system shall be buried and shall be connected using compatible Ethernet cable or suitable equivalent. Coordinate with SCADA integrator and the OWNER for signal connection location to the monitoring and alarm system.

B. Process monitoring systems shall be handled, installed, calibrated, loop-tested, pre-commissioned, and performance tested in accordance with Section 40 91 00 - SCADA Systems and Equipment. Manufacturer's service, supervision, and training shall also be in accordance with Section 40 91 00 - SCADA Systems and Equipment.

END OF SECTION

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SECTION 43 20 00 - PUMPS, GENERAL

PART 1 - GENERAL

1.1 THE SUMMARY

A. Provide pumps and pumping appurtenances, complete and operable, as indicated in accordance with the Contract Documents.

B. The provisions of this Section shall apply to pumps and pumping equipment throughout the Contract Documents, except where otherwise indicated.

C. The requirements of Section 46 01 00 – Equipment General Provisions, apply to this Section.

D. Unit Responsibility

1. The pump manufacturer shall be made responsible for furnishing the pumps, motors, and VFDs as one package and for the coordination of design, assembly, testing, and installation of the WORK of each specific pump Section.

2. The CONTRACTOR shall be responsible to the OWNER for compliance with the requirements of each specific pump Section.

E. Single Manufacturer

1. Where 2 or more pump systems of the same type or size are required, provide pumps produced by the same manufacturer.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals.

B. Shop Drawings

1. Submit pump name, identification number, and specification Section number.

2. Performance Information:

a. Submit performance data curves showing head, capacity, horsepower demand, NPSHr3 required, and pump efficiency over the entire operating range of the pumps. Submit efficiency curves of motors and VFDs.

b. Require the equipment manufacturer to indicate the head, capacity, required horsepower, pump efficiency, and NPSHr corresponding to each flow condition indicated in the respective performance requirement paragraph of each individual pump specification section. Indicate on the pump curve the Allowable Operating Region (AOR), Preferred Operation Region (POR), and minimum submergence required at maximum flow for submersible pumps.

c. Submit performance curves at intervals no greater than 100 RPM from the specified minimum speed to maximum speed for each pump equipped with a variable speed drive.

3. Operating Range - The performance curves shall indicate the manufacturer-recommended limits for stable operation without surge, cavitation, or excessive vibration.

4. Submit assembly and installation drawings, including shaft size, seal, coupling, bearings, anchor bolt plan, part nomenclature, material list, outline dimensions, and shipping weights.

5. Submit data, in accordance with the requirements of Section 26 05 10 – Electric Motors, for the electric motor proposed for each pump.

6. Submit an elevation drawing of the proposed local control panel, showing panel-mounted devices, details of enclosure type, a single-line diagram of power distribution, current draw of the panel, and a list of terminals required to receive inputs or to transmit outputs from the local control panel.

7. Submit a wiring diagram of field connections, with identification of terminations between local control panels, junction terminal boxes, and equipment items.

8. Technical Manual

   a. Submit a Technical Manual containing the required information indicated in Section 01 33 00 – Contractor Submittals and each specific pump Section.

9. Spare Parts List

   a. Submit a spare parts list containing the required information indicated in Section 01 33 00 – Contractor Submittals and each specific pump Section.

10. Certifications

    a. Submit the manufacturer's certification of proper installation.

    b. Submit the CONTRACTOR's certification of satisfactory field testing.

PART 2 - PRODUCTS

2.1 GENERAL

A. Compliance with the requirements of the specific pump Sections may necessitate modifications to the manufacturer's standard equipment.

B. Compatibility

1. Provide entirely compatible components of each pump system provided under the specific pump Sections.

2. In each unit of pumping equipment, incorporate basic mechanisms, couplings, electric motors or engine drives, variable speed controls, necessary mountings, and appurtenances.

2.2 MATERIALS

A. Provide materials suitable for the intended application.

B. For materials not indicated, provide high-grade, standard commercial quality, free from defects and imperfections that might affect the serviceability of the product for the purpose for which it is intended, and conforming to the following requirements.

C. Pump control panels, whether fabricated specially or provided as part of a supplier package, shall be provided with stainless steel enclosures. See requirements of Section 26 05 15 Industrial Control Panels.

2.3 PUMP COMPONENTS - GENERAL

A. Flanges and Bolts

1. Provide suction and discharge flanges conforming to ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, or ASME B16.5 - Pipe Flanges and Flanged Fittings dimensions. Pressure class shall be suitable for the application or as otherwise recommended by the pump manufacturer.

2. Provide flange bolts in accordance with the requirements of Section 40 05 00 – Piping, General.

3. Flange gaskets shall be in accordance with Section 40 05 00 - Piping, General

2.4 PUMP APPURTENANCES

A. Nameplates

1. Equip each pump with a stainless steel nameplate indicating serial number(s), rated head and flow, impeller size, pump speed, and manufacturer's name and model number.

B. Gauges

1. Except for sample pumps, sump pumps, and hot water circulating pumps, equip pumps with pressure gauges installed at the pump discharge lines.

2. Provide pressure and compound gauges in accordance with the requirements of Section 40 91 08 – Pressure Measuring.

2.5 FACTORY TESTING

A. Conduct the following tests on each indicated pump system:

1. Motors

a. Test electric motors in accordance with the requirements of Section 26 05 10 – Electric Motors.

b. Furnish test results to the pump manufacturer prior to the pump test.

2. Variable Frequency Drives

a. Test variable frequency drives in accordance with the requirements of Division 26 – Variable Speed Drives section.

b. Furnish test results to the pump manufacturer prior to the pump test.

3. Certified Factory Non-witnessed Test

a. Perform factory non-witnessed tests on rotary lobe or centrifugal pumps with drives up to and including 125 hp in accordance with the ANSI/HI 14.6, Rotodynamic Pumps for Hydraulic Performance Acceptance Test.

b. For pumps with drives smaller than 15 hp, sump pumps, and sample pumps, pumps shall meet hydraulic acceptance criteria Grade "2U" unless otherwise indicated. Such tests shall, at a minimum, consist of the following:

1) Hydrostatic test;

2) Performance test at guaranteed design point or duty point documenting head, flow, bhp, and efficiency results.

3) Unless otherwise indicated, it is not required to test NPSHr in the factory. Instead, manufacturer shall submit the published NPSHr curve in accordance with the requirements of this specification section.

4) Additional tests as indicated in the specific pump specification sections.

c. For pumps with drives 15 hp and larger shall meet hydraulic acceptance criteria Grade "1U" unless otherwise indicated. Such tests shall, at a minimum, consist of the following:

1) Hydrostatic test;

2) Performance Test:

a) Conduct performance testing at maximum speed, obtain a minimum of 5 hydraulic test readings between shutoff head and 25 percent beyond the maximum indicated capacity, and record on data sheets as defined by the Hydraulic Institute Standards;

b) For variable speed driven pumps, test each pump between maximum and minimum speed at intervals no greater than 100 RPM;

c) Submit pump curves showing head, flow, bhp, NPSHr and efficiency results. The manufacturer’s certification shall be visible on each submitted curve;

3) Mechanical testing shall be limited to observation during the hydraulic performance test for any abnormal bearing temperature and pump vibration. Any deficiencies shall be corrected by the manufacturer.

4) NPSHr3

a) Perform a net positive suction head required test (NPSHr3), if required by the specific pump Section.

b) Acceptance criteria shall be in accordance with ANSI/HI 14.6

c) If not required by the specific pump Section, submit the published manufacturer-calculated NPSHr3 curve.

5) Additional tests as indicated in the specific pump specification sections.

d. Perform tests using the completely assembled project pump, motor, and VFD system (if equipped with variable speed drive). Calibrated factory motor may be used in lieu of project motor subject to approval of the ENGINEER.

e. Where multiple pumps are required in the project, one project variable speed drive and motor of each size shall be used for testing pumps as completely assembled systems.

f. Testing of prototype models will not be accepted.

g. Submit certification signed by a senior official of the pump manufacturer that the required pump shaft horsepower did not exceed the rated motor horsepower of 1.0 service rating at any point on the curve.

h. No equipment shall be shipped until the test data have been approved by the ENGINEER.

4. Certified Factory Witnessed Tests

a. Perform factory witnessed tests on centrifugal pumps with drives 150 hp and larger in accordance with the certified factory non-witnessed test procedure indicated above for 15 hp to 125 hp pumps with the exception that the tests shall be witnessed by the OWNER and ENGINEER. Where multiple pumps are required in the project, one project variable speed drive and motor of each size shall be used for testing pumps as completely assembled systems.

b. Mechanical tests shall be conducted in accordance with ANSI/HI 14.6, Appendix E, Mechanical Test. Such tests shall, at a minimum, consist of the following;

1) Measure and record overall motor winding temperature.

2) Measure and record motor and pump bearing temperatures.

3) Measure and record motor and pump vibration.

4) Acceptance criteria and mechanical test records shall be in accordance with ANSI/HI 14.6, Appendix E, Mechanical Test.

c. The CONTRACTOR shall provide the OWNER and ENGINEER a minimum of 2 weeks notification prior to the test.

d. Excluding salaries, costs for the attendances of one representative for the OWNER and one representative for the ENGINEER shall be borne by the CONTRACTOR and shall be included in the Contract Price, including travel and subsistence costs. The cost shall include repetitive visits, if required. If additional witnessed testing is required due to failure of the pumps to meet specified conditions, expenses of the ENGINEER and OWNER shall be covered by the CONTRACTOR.

e. No equipment shall be shipped until the test data have been approved by the ENGINEER.

5. Acceptance

a. In the event of failure of any pump to meet any of the requirements, make necessary modifications, repairs, or replacements in order to conform to the requirements of the Contract Documents, and re-test the pump until found satisfactory.

PART 3 - EXECUTION

3.1 MANUFACTURER'S SERVICES

A. Inspection, Startup, and Field Adjustment

1. Where required by the specific pump Section, furnish an authorized service representative of the manufacturer at the Site continuously to supervise the following items and to certify in writing that the equipment and controls have been properly installed, aligned, lubricated, adjusted, and readied for operation:

a. Installation of the equipment;

b. Inspection, checking, and adjusting the equipment;

c. Startup and field testing for proper operation; and

d. Performance of field adjustments to ensure that the equipment installation and operation comply with the indicated requirements.

B. Instruction of OWNER's Personnel

1. Where required by the individual pump Section, furnish an authorized training representative of the manufacturer at the Site for the number of Days indicated in the specific pump Section, to instruct the OWNER's personnel in the operation and maintenance of the equipment, including step-by-step troubleshooting with necessary test equipment.

3.2 INSTALLATION

A. General

1. Install pumping equipment in accordance with the manufacturer's written recommendations.

B. Alignment

1. Field-test the equipment in order to verify proper alignment and freedom from binding, scraping, shaft run out, or other defects.

2. Ensure that the equipment is secure in position and neat in appearance.

C. Lubricants

1. Provide the necessary oil and grease for initial operation.

3.3 PROTECTIVE COATING

A. Coat materials and equipment in accordance with the requirements of Section 09 96 00 – Protective Coating.

3.4 FIELD TESTS

A. Field-test each pump system after installation simulating all of the operational scenarios as specified in order to demonstrate:

1. Satisfactory operation without excessive noise and vibration;

2. No material loss caused by cavitation;

3. No overheating of bearings; and,

B. Conduct the following field testing:

1. Startup, check, and operate the pump system over its entire speed range.

2. If the pump is driven by a variable speed drive, test the pump and motor at 100-RPM increments.

3. If the pump is driven by constant speed, test the pump and motor at the maximum RPM.

4. Check each power lead to the motor for proper current balance.

5. Bearing Temperatures

a. Determine bearing temperatures by a contact-type thermometer.

b. Precede this test with a run time sufficient to stabilize bearing temperatures, unless an insufficient liquid volume is available to furnish such a run time.

6. Ensure that electrical and instrumentation tests conform to the requirements of the Section under which that equipment is specified.

C. Certification

1. After each pumping system has satisfied the requirements, certify in writing that it has been satisfactorily tested and that final adjustments have been performed.

2. Certification shall include the date of the field tests, a listing of persons present during the tests, and the test data.

D. The CONTRACTOR shall be responsible for costs of field tests, including related services of the manufacturer's representative, except for power and water, which the OWNER will bear.

E. If available, the OWNER'S operating personnel will provide assistance in field testing.

END OF SECTION

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SECTION 43 23 58 – LOBE PUMPS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The Contractor shall provide rotary lobe pumps and appurtenant Work, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 43 20 00 – Pumps, General apply to this Section.

C. The Supplier shall examine the Site conditions, intended application, and operation of the pump system and recommend the pump that will best satisfy the indicated requirements.

1.2 CONTRACTOR SUBMITTALS

A. Shop Drawings

1. In addition to the requirements of Section 43 20 00 – Pumps, General, the following shall be submitted in conformance with Section 01 33 00 – Submittal Procedures:

a. Technical brochures, bulletins, and data sheets for all control and instrumentation components.

1.3 WARRANTY

A. In addition to the requirements of Section 46 01 00 – Equipment General Provisions, the following warranty requirements shall apply:

1. The equipment manufacturer shall guarantee the integrity of the equipment, including controls, appurtenances and supports, for 5 years after final acceptance with a warranty against all defects in workmanship and materials.

2. The Warranty shall include any damage sustained by the pump due to overpressure.

PART 2 -- PRODUCTS

2.1 GENERAL DESCRIPTION

A. Identification:

Pump Name	Equipment Numbers	Quantity	Location
TRENCH DRAIN PUMP 1	5-P-3	1	Area 5
TRENCH DRAIN PUMP 2	5-P-4	1	Area 5

B. Operating Conditions: The Work of this Section shall be suitable for long term operation under the conditions as indicated on the Pump Schedule.

Duty	Continuous
Drive	Variable speed
Ambient environment	Outdoor
Fluid service	Dilute sludge
Fluid temperature, degrees F	40 to 70
Fluid pH range	6 to 8
Project site elevation, ft. msl	18
Minimum available NPSH, ft absolute	10
Maximum dia. of spheres to pass, in.	3/8

C. Performance Requirements: The Work of this Section shall meet the performance requirements as indicated on the Pump Schedule.

Pump Number	5-P-3	5-P-4
Design flow capacity, gpm	125	125
Design flow pump head, TDH ft	27	27
Design flow minimum pump efficiency, percent	60	60
Maximum motor size, hp	5	5
Motor Volts/Phases/Hz	480/3/60	480/3/60

2.2 PUMP REQUIREMENTS

A. General

1. The pumps shall be of the positive displacement, rotary-lobe type, designed to pump the indicated fluid service.

2. The lobes, wear plates, and mechanical seals shall be accessible without the need for removing the pump from its installed position.

3. Provide integral drain taps on the bottom of discharge and suction fittings on pump.

4. Top and bottom pump housing: Top and bottom segments of the pump shall be adjustable based on wear up to 3 millimeters. The adjustment shall be accomplished by simply moving stainless steel shims from one hole to the next in the pump housing, allowing for the closing of tolerance around the rotors. This adjustment must be available a minimum of 2 times from factory tolerance.

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5. In lieu of providing adjustable top and bottom segments, manufacturer may provide radial wear plates on the casing walls that utilize the same philosophy as the front and rear wear plates. The radial wear plates shall be designed to allow the Owner to replace the worn component and bring the radial casing back to factory tolerance.

6. Lobes

    a. The manufacturer shall recommend the proper lobe configuration.

    b. Lobes shall be of a pulsation-free design.

7. Rotors

    a. Rotors shall be driven through positive straight-cut timing gears running in oil.

    b. Rotors shall be positioned to the shaft by means of replaceable, hardened key ways.

8. The pumps shall be designed to run dry and shall be designed to allow operation in either direction.

9. Seals

    a. An intermediate oil-filled chamber between the pump casing and the gearbox shall lubricate and cool (oil-quench) double-lip mechanical seals.

    b. Seal designs that open during rotor replacement will not be accepted.

10. The pump and drive shall be fitted on a common stainless-steel base.

11. Flanges

    a. The pump shall be provided with stainless steel or galvanized steel flanges.

12. Noise and Vibration

    a. The pumps and motors shall operate at any point within their operating range without undue noise and vibration.

    b. Vibration at any point within the operating range shall be within the limits allowed by the Hydraulic Institute.

13. The pumps shall be equipped with an internal, integral overpressure device as manufactured by the pump manufacturer, or with another means of mechanical overpressure protection.

B. Construction: Rotary lobe pumps shall conform to the following requirements:

Casing and End Cover	Cast iron ASTM A48 grade 40, 264 Brinell hardness
Radial pump casing wear plates	Minimum 550 Brinell hardness
Rear and Front casing wear plates	Minimum 550 Brinell hardness

Shafts	Carbon steel, AISI 4140 or ASTM A293
Rotor or Lobe Tip Material	Cast iron core with urethane or Buna-bonded covering, Shore hardness 65-72, ASTM E448
Mechanical Seal	Double-lip or cartridge type, oil-quenched
Bearings	Provide 2 sets of high-quality ball bearings, the inboard set being single-ball race and the outboard set being dual-ball race, all with an L-10 life of 100,000 hours.
Lubrication	Casings shall be oil-filled and maintenance-free

C. All elastomeric materials such as O-rings and gaskets shall be compatible with the fluid.

D. Drive

1. Electric motors shall be furnished in accordance with Section 26 05 10 – Electric Motors. Where an individual Equipment Datasheet indicates a driver requirement for variable speed operation, such pumps shall be furnished with variable frequency drives in accordance with Section 26 29 23 - Variable Frequency Drive Units.

2. The pump, gear reducer, and motor shall have a combined minimum overall efficiency of 80 percent at full speed, and 70 percent at half speed.

3. Appurtenances

   a. A combined oil temperature and level gauge shall be mounted on the side of the drive.

   b. The drive shall be provided with a stainless-steel drain plug at each corner for easy access.

   c. The drive shall be provided with pressure compensation for overload protection.

2.3 PUMP CONTROLS

A. Pumps shall be controlled in accordance with Section 40 90 10 – Control Strategies.

B. The drive speed shall be controlled from a remotely located control board.

C. Load Sensor

1. The drive shall be provided with a load-sensing control which shall sense high torque caused by either jams or overpressure.

2. When a jam or overpressure occurs, the control shall stop the pump instantly, then pause in neutral for a period of 0-10 seconds (adjustable), then restart in the forward mode.

3. If the pump then jams again, the control shall shut the unit down, and a signal for a remote alarm shall be provided.

D. A temperature switch shall be integrated into the radial wear plate in order to sense a dry run condition and shut down the pump.

E. Coating: Interior water passages of cast iron and ductile iron casing and impellers shall be coated with 10- to 12-mils DFT vitreous enamel or 10- to 12-mils DFT fusion bonded epoxy per Section 09 96 00 – High-Performance Coatings. All external surfaces of cast iron and carbon steel materials shall be coated in accordance with Section 09 96 00 – High-Performance Coatings.

2.4 SPARE PARTS

A. Furnish spare parts for each pump.

B. Special tools: For each type or size of pump specified, provide 1 set of all special tools required for complete assembly or disassembly of the pump system components.

2.5 MANUFACTURERS, OR EQUAL

A. Boerger Pumps, LLC

B. Vogelsang

PART 3 -- EXECUTION

3.1 SERVICES OF MANUFACTURER

A. Inspection, Startup, and Field Adjustment: The service representative of the manufacturer shall be present continuously at the Site to furnish the services required by Section 43 20 00 – Pumps, General.

B. Instruction of Owner's Personnel: The training representative of the manufacturer shall be present at the Site for 3 Days to furnish the services required by Section 43 20 00 – Pumps, General.

C. For the purpose of this paragraph, a Day is defined as an 8-hour period at the Site, excluding travel time.

D. The Engineer may require that the inspection, startup, and field adjustment services above be furnished in 3 separate trips.

END OF SECTION

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SECTION 43 25 05 - SUBMERSIBLE SUMP PUMPS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide submersible sump pumps and appurtenant WORK, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 43 20 00 - Pumps, General apply to this Section.

C. The Supplier shall examine the Site conditions, intended application, and operation of the pump system and recommend the pump that will best satisfy the indicated requirements.

1.2 1 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 43 20 00 – Pumps, General and Section 01 33 00 – Contractor Submittals.

PART 2 -- PRODUCTS

2.1 GENERAL DESCRIPTION

A. Identification:

3-P-1	Distribution Box Utility Water Supply Pump
3-P-2	Distribution Box Truck Fill Pump

B. Operating Conditions: The WORK of this Section shall be suitable for long term operation under the conditions:

Duty	Intermittent
Drive	Constant speed
Ambient environment	Outdoor sump
Fluid service	Water
Fluid temperature, degrees F	40 to 70
Fluid pH range	6 to 8
Project site elevation, ft. a.s.l	18
Minimum available NPSH, ft absolute	37
Maximum dia. of spheres to pass, in.	0.5

C. Performance Requirements (All pumps):

Pump	3-P-1	3-P-2
Design flow capacity, gpm	104	300
Design flow pump head, TDH ft	70	46
Design flow minimum pump efficiency, percent	40	40
Maximum motor size, hp	5	11
Motor Volts/Phases/Hz	480/3/60	480/3/60

2.2 PUMP REQUIREMENTS

A. Construction: Construction of submersible sump pumps shall conform to the following requirements:

Pump casing	Polypropylene or Cast iron
Impeller	Semi-open, non-clog
Bearings	Permanently lubricated ball and sleeve type
Shaft	Stainless steel, series 400
Seal	Mechanical seal
Mounting Method	stainless steel chain and hook
Check Valve	Integral with pump
Pump Connection	threaded with neoprene pressure hose

B. Drive: Enclosed, submerged, electric motor, suitable for 480-volt, 3 phase or 120-volt, single phase, 60 Hz ac power supply.

C. Coating: Provide manufacturer's standard coating

2.3 PUMP CONTROLS

A. Pumps shall be equipped with integral float switches for controlling pump start and stop. A separate high level float switch for the sump shall be furnished as part of, and as specified under, Division 40.

B. Each pump shall be supplied with a vendor-supplied control panel (VCP) and shall house all required controls, circuit breakers, motor starters, and contacts. The VCP shall have a HAND/OFF/AUTO hand switch to permit local operation of each pump, and indicator lights

for RUN status and FAIL status. The VCP shall have dry contacts to provide remote monitoring via OWNER's PLC of all status signals as shown on the Contract Documents, which shall include at a minimum RUN status and FAIL status.

2.4 MANUFACTURERS, OR EQUAL

A. **ABS Pumps, Inc.**

B. **Goulds Pumps Inc.**

C. **Aurora Pumps**

D. **Yeomans-Morris-Chicago Pump Company**

E. **Crane-Deming**

F. **Flygt Corporation**

G. **Pacific Pumping Company**

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Pumping equipment shall be installed in accordance with the Shop Drawings and as indicated.

B. General installation requirements shall be in accordance with Section 43 20 00 - Pumps, General.

END OF SECTION

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SECTION 43 25 06 - SUBMERSIBLE SOLIDS-HANDLING PUMPS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide submersible sump pumps and appurtenant WORK, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 43 20 00 - Pumps, General apply to this Section.

C. The Supplier shall examine the Site conditions, intended application, and operation of the pump system and recommend the pump that will best satisfy the indicated requirements.

PART 2 -- PRODUCTS

2.1 GENERAL DESCRIPTION

A. Identification:

5-P-1, 5-P-2	Lower Pond Reuse Pumps 1 and 2
6-P-1, 6-P-2	Spawning Waste Pump Station

B. Operating Conditions: The WORK of this Section shall be suitable for long term operation under the following conditions:

Duty	Continuous
Drive	Variable speed
Ambient environment	Outdoor sump
Fluid service	Dilute sludge
Fluid temperature, degrees F	40 to 70
Fluid pH range	6 to 8
Project site elevation, ft. msl	18
Minimum available NPSH, ft absolute	20
Maximum dia. of spheres to pass, in.	1

C. Performance Requirements:

Pump Number	5-P-1, 5-P-2	6-P-1, 6-P-2
Design flow capacity, gpm	2250	200
Design flow pump head, TDH ft	100	35
Design flow minimum pump efficiency, percent	60	60
Maximum motor size, hp	100	2
Motor Volts/Phases/Hz	480/3/60	208/3/60

2.2 PUMP REQUIREMENTS

A. Construction: Construction of submersible sump pumps shall conform to the following requirements:

Pump casing	Cast iron
Impeller	Semi-open, non-clog cast iron
Bearings	Permanently lubricated ball and sleeve type
Shaft	Stainless steel, series 400
Seal	Mechanical seal
Mounting Method	Slide rail with stainless steel chain and hook
Pump Connection	Flange

B. Drive: Enclosed, submerged, electric motor, suitable for 480-volt, 3 phase or 208-volt, 3 phase or 120-volt, 1 phase, 60 Hz ac power supply.

2.3 PUMP CONTROLS

A. Pumps shall be controlled in accordance with Section 40 90 10 - Control Strategies.

B. Local pump control panels shall be mounted near each pump sump station. The control cabinets shall be NEMA 4X construction with a lockable main power fused disconnect switch. All controls shall be located behind a lockable front panel on an inside swing out panel. Provide run indicator lights for each pump.

C. The pumps shall be operated automatically through actuation of non-mercury float switches in the sump. The pumps shall operate in a “Duty-Standby” mode with automatic Duty-Standby pump alternation to ensure even running time. With the HOA selector in the

local control panel, is set in “AUTO” mode, the Duty pump shall run when the “PUMP ON” float switch is triggered and turn off when “PUMP OFF” float switch is triggered. The Standby pump shall start when the “HIGH LEVEL” float switch is triggered and turn off when the “PUMP ON” float switch is triggered. When the HOA selector is set in “HAND” mode, the operator shall operate the pumps manually with RUN-STOP switches.

2.4 PROTECTIVE COATING

A. Pumps shall be coated with manufacturer’s standard coating.

2.5 MANUFACTURERS, OR EQUAL

A. **Ebara**

B. **Aurora Pumps**

C. **Flygt Corporation**

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Pumping equipment shall be installed in accordance with the Shop Drawings and as indicated.

B. General installation requirements shall be in accordance with Section 43 20 00 - Pumps, General.

END OF SECTION

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SECTION 43 30 00 - VALVES, GENERAL

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Provide valves, actuators, and appurtenances, complete and operable, as indicated in accordance with the Contract Documents.

B. The requirements of Section 46 01 00 – Equipment General Provisions, apply to the WORK of this Section.

C. The provisions of this Section shall apply to all valves and valve actuators except where otherwise indicated.

D. Valves and actuators in particular locations may require a combination of units, sensors, limit switches, and controls, as indicated.

E. Support

1. Where a valve is to be supported by means other than the piping to which it is attached, obtain from the valve manufacturer a design for its support and foundation that satisfies the criteria in Section 46 01 00 – Equipment General Provisions.

2. Submit the support design, including drawings and calculations sealed by an engineer, with the Shop Drawings.

F. Unit Responsibility

1. The CONTRACTOR shall assign a single manufacturer to be responsible for the supply, coordination of design, assembly, testing, and furnishing of each valve; however, the CONTRACTOR shall be responsible to the OWNER for compliance with the requirements of each valve Section.

G. Single Manufacturer

1. Where 2 or more valves of the same type and size are required, the valves shall be furnished by the same manufacturer.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals.

B. Furnish the following information on Shop Drawings:

1. Valve name, size, Cv factor, pressure rating, identification number (if any), and specification section number;

2. Complete information on the valve actuator, hydraulic power units (HPU), pneumatic air supply system including size, manufacturer, model number, limit switches, and mounting;

3. Cavitation limits for control valves;

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4. Assembly drawings showing part nomenclature, materials, dimensions, weights, and relationships of valve handles, hand wheels, position indicators, limit switches, integral control systems, needle valves, and control systems;

5. Complete wiring diagrams and control system schematics; and,

6. A valve-labeling schedule, listing the valves to be furnished with stainless steel tags, indicating in each case the valve location and the proposed wording for the label.

C. Furnish a technical manual containing the required information for each valve, as indicated.

D. Furnish a spare parts list, containing the required information for each valve assembly, as indicated.

E. Factory Test Data

1. Where indicated, submit signed, dated, and certified factory test data for each valve requiring certification, before shipping the valve.

2. Furnish a certification of quality and test results for factory-applied coatings.

F. Field Test Data

1. Submit signed, dated, and certified field test data for each valve.

PART 2 -- PRODUCTS

2.1 PRODUCTS

A. General

1. Provide valves and gates of new and current manufacture.

2. Provide valves 6-inch and larger with actuators with position indicators.

3. Unless otherwise indicated, provide valve actuators in accordance with Section 43 30 12 – Valve and Gate Actuators.

B. Protective Coating

1. Coat the exterior surfaces of valves and the wet interior surfaces of ferrous valves of sizes 2-inch and larger in accordance with the requirements of Section 09 96 00 – Protective Coating.

2. The valve manufacturer shall certify in writing that the required coating has been applied and tested in the manufacturing plant prior to shipment, in accordance with the indicated requirements.

3. Do not coat the machined flange faces of valves except where such flanges are not adjoining a mating flange as shown in the Contract Documents. Apply rust inhibitor coating on machined surfaces of the flange prior to shipment.

C. Valve Labeling

1. Except when such requirement is waived by the ENGINEER in writing, provide a label on shut-off valves and control valves except for hose bibbs.

2. Furnish a label composed of 1/16-inch plastic or stainless steel, a minimum of 2 inches by 4 inches in size, as indicated in Section 43 10 51 – Piping Identification Systems, and permanently attached to the valve or on the wall adjacent to the valve as directed by the ENGINEER.

D. Valve Testing

1. As a minimum, unless otherwise indicated or recommended by the reference standards, test valves 3 inches in diameter and smaller in accordance with the manufacturer's standard procedure.

2. Factory-test valves 4 inches in diameter and larger as follows:

a. Hydrostatic Testing

1) Subject valve bodies to an internal hydrostatic pressure equivalent to twice the water-rated pressure of the valve.

2) Metallic valves rating pressures shall be based at 100 degrees F.

3) Plastic valves rating pressures shall be based at 73 degrees F, or at a higher temperature according to material type.

4) During the hydrostatic test, there shall be no visible leakage through the valve body, end joints, or shaft seals, nor shall parts of the valve be permanently deformed.

5) Allow test duration of at least 10 minutes, in order to allow visual examination for leakage.

b. Seat Testing

1) Test the valves for leaks in the closed position, with the pressure differential across the seat equal to the water rated pressure of the valve.

2) Provide test duration of at least 10 minutes, in order to allow visual examination for leakage.

3) The leakage rate shall be the more stringent of the following:

a) As recommended by the reference standard for that type of valve; or

b) Leakage past the closed valve not to exceed one fluid ounce per hour per inch diameter for metal seated valves, and drop-tight for resilient seated valves.

c. Performance Testing

1) Shop-operate the valves from the fully-closed to the fully-open position, and reverse under no-flow conditions in order to demonstrate that the valve assembly operates properly.

E. Certification

1. Prior to shipment of valves with sizes larger than 12-inches in diameter, submit certified, notarized copies of the hydrostatic factory tests, showing compliance with the applicable standards of AWWA, ANSI, or ASTM.

F. Valve Markings

1. Permanently mark valve bodies in accordance with MSS SP25 - Standard Marking Systems for Valves, Fittings, Flanges, and Unions.

2.2 MATERIALS

A. General

1. Provide materials suitable for the intended application.

2. Provide materials in contact with potable water listed as compliant with NSF Standard 61.

3. Ensure that materials not indicated are of high-grade standard commercial quality, free from defects and imperfections that might affect the serviceability of the product for the purpose for which it is intended.

4. Unless otherwise indicated, provide valve and actuator bodies conforming to the following requirements:

a. Cast Iron: Close-grained gray cast iron, conforming to ASTM A 48 - Gray Iron Castings, Class 30, or to ASTM A 126 - Gray Iron Castings for Valves, Flanges, and Pipe Fittings

b. Ductile Iron: ASTM A 536 - Ductile Iron Castings, or to ASTM A 395 - Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures

c. Steel: ASTM A 216 - Steel Castings, Carbon Suitable for Fusion Welding for High-Temperature Service, or to ASTM A 515 - Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service

d. Bronze: ASTM B 62 - Composition Bronze or Ounce Metal Castings, and valve stems not subject to dezincification shall conform to ASTM B 584 - Copper Alloy Sand Castings for General Applications. Bronze materials in contact with potable water service shall be free of lead content meeting the Lead Reduction Act.

e. Stainless Steel: Stainless steel valve and operator bodies and trim shall conform to ASTM A 351 - Steel Castings, Austenitic, for High-Temperature Service, Grade CF8M, or shall be Type 316 stainless steel

f. PVC: Polyvinyl chloride materials for valve body, flanges, and cover shall conform to Cell Classification 12454

g. CPVC: Chlorinated Poly Vinyl Chloride materials for valve body, flanges, and cover shall conform to Cell Classification 23447

h. NSF Standard 61: Materials shall be listed for use in contact with potable water.

i. Elastomeric materials used for seat, seals and O-rings shall be compatible with temperature, pressures and fluid or gas service.

1) Elastomeric materials for water with chloramines shall be Teflon or Viton-A.

2) Elastomeric materials for water with dissolved ozone residual shall be Teflon suitable for ozone service.

3) Elastomeric materials for oxygen (LOX or GOX) shall be Teflon specially manufactured and packaged suitable for oxygen service.

2.3 VALVE CONSTRUCTION

A. Bodies

1. Provide valve bodies that are cast, molded (in the case of plastic valves), forged, or welded, of the materials indicated, and with smooth interior passages.

2. Provide wall thicknesses uniform and in agreement with the applicable standards for each type of valve, without casting defects, pinholes, and other defects that could weaken the body.

3. Perform welds on welded bodies by certified welders and ground welds smooth.

4. Provide valve ends as indicated, and rated for the maximum temperature and pressure to which the valve will be subjected.

B. Valve End Connections

1. Unless otherwise indicated, valves 2-1/2 inches in diameter and smaller may be provided with threaded end connections.

2. Provide valves 3 inches in diameter and larger with flanged end connections.

3. Flanges, bolts, and gaskets shall be as specified in Section 40 05 00 - Piping, General.

C. Bonnets

1. Connect valve bonnets to the body by clamping, screwing, or flanging.

2. Provide bonnets of the same material, temperature, and pressure rating as the body.

3. Make provisions for the stem seal with the necessary glands, packing nuts, and yokes.

D. Stems

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1. Provide valve stems of the materials indicated, or, if not indicated, of the best commercially-available material for the specific service, with adjustable stem packing, O-rings, chevron V-type packing, or other suitable seal. Bronze materials in contact with potable water shall be NSF 61 approved and free of lead. Elastomeric materials shall be compatible with fluid service.

E. Stem Guides

1. Provide stem guides spaced with an L/R ratio not to exceed 200:1. Submit calculations for L/R ratios and guide spacing to the ENGINEER for review.

2. Stem guides shall have slotted holes and shall be adjustable in two directions.

3. Construct submerged stem guides from Type 316 stainless steel.

F. Internal Parts

1. Provide internal parts and valve trim as indicated for each individual valve.

2. Where not indicated, construct valve trim from Type 316 stainless steel or other material best-suited for the intended service.

G. Nuts and Bolts

1. Unless otherwise indicated, provide nuts and bolts on valve flanges and supports in accordance with the requirements of Section 05 50 00 – Miscellaneous Metalwork and Section 43 10 50 – Piping, General.

2.4 Torque Tubes

A. Submerged or buried valves with a remote gearbox and actuator shall be supplied with a torque tube to transfer torque from the actuator to the valve. Torque tubes shall be directly connected to the valve and the floor stand and gear actuator. Each torque tube and floor stand shall be sized to operate under the maximum service conditions for the valve. Unless otherwise indicated, torque tubes shall be made of schedule 40, steel pipe with epoxy coating suitable for the fluid service. Each submerged valve, torque tube, floor stand and actuator shall be pre-assembled and “matched marked” in the manufacturer’s shop to ensure proper fit when assembled in field.

2.5 Extension Shaft Stem

A. Valves mounted in dry areas with gearbox attached to the valve and with remote actuator shall be supplied with an extension shaft stem with universal joint attached to the gear and actuator. All components shall be sized to operate under the maximum service conditions for the valve. Unless otherwise indicated, shaft stem and universal joints shall be made of carbon steel with epoxy coating suitable for the fluid service. Each valve, shaft stem, floor stand and actuator shall be pre-assembled and “matched marked” in the manufacturer’s shop to ensure proper fit when assembled in field.

2.6 VALVE ACTUATORS

A. Valve actuators shall be as indicated and as specified in Section 43 30 12 – Valve and Gate Actuators

2.7 VALVE ACCESSORIES

A. Provide valves complete with the accessories required to provide a functional system.

2.8 SPARE PARTS

A. Furnish the required spare parts, suitably packaged and labeled with the valve name, location, and identification number.

B. Furnish the name, address, and telephone number of the nearest distributor for the spare parts of each valve.

C. Spare parts are intended for use by the OWNER, after expiration of the correction of defects period.

2.9 MANUFACTURERS

A. Valve manufacturers shall have a successful record of not less than 5 years in the manufacture of the indicated valves.

PART 3 -- EXECUTION

3.1 VALVE INSTALLATION AND TRIAL OPERATION

A. General

1. Install valves, actuating units, stem extensions, valve boxes, and accessories in accordance with the manufacturer's written instructions and as indicated.

2. Adequately brace gates in order to prevent warpage and bending under the intended use.

3. Firmly support valves in order to avoid undue stresses on the pipe.

B. Access

1. Install valves in a manner to provide easy access for actuation, removal, and maintenance, and to avoid interference between valve actuators and structural members, handrails, and other equipment.

C. Valve Accessories

1. Where combinations of valves, sensors, switches, and controls are indicated, properly assemble and install such items such that systems are compatible and operating properly.

2. Clearly note the relationship between interrelated items on Shop Drawing submittals.

D. Trial Operation

1. After installation, schedule trial operation witnessed by the ENGINEER and the OWNER representative.

2. All valves shall be cleaned thoroughly of all foreign materials and final adjustments made. The valves shall then be operated through one complete cycle from a fully closed

position to a fully open position and back to a fully closed position to verify that the assembly is functional.

3. For control valves that operate in multiple operating scenarios, the CONTRACTOR shall simulate all operational scenarios including the hydraulic power units, pilot control system or pneumatic air supply system to demonstrate compliance to the specifications.

4. A field leakage test meeting the maximum allowable specified requirement shall be conducted.

5. Test certificate shall be signed by the valve manufacturer and the CONTRACTOR and shall be submitted to the ENGINEER.

END OF SECTION

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SECTION 43 30 12 - VALVE AND GATE ACTUATORS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Provide valve and gate actuators and appurtenances, complete and operable, as indicated in accordance with the Contract Documents.

B. The provisions of this Section apply to valves and gates except where otherwise indicated in the Contract Documents.

C. Unit Responsibility

1. Make the valve or gate manufacturer responsible for the coordination of design, assembly, testing, and installation of actuators on the valves and gates; however, the CONTRACTOR shall be responsible to the OWNER for compliance of the valves, gates, and actuators with the Contract Documents.

D. Where 2 or more valve or gate actuators of the same type or size are required, the actuators shall be produced by the same manufacturer.

E. The requirements of Section 26 05 15 – Industrial Control Panels apply to the WORK of this Section.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals and Section 43 30 00 – Valves, General.

B. Submit Shop Drawing information for actuators with the valve and gate submittals as a complete package.

C. Submit calculations showing dynamic seating and unseating torques versus the output torque of the actuator.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Unless otherwise indicated, provide shut-off and throttling valves and externally actuated valves and gates with manual or power actuators.

B. Provide actuators complete and operable with mounting hardware, motors, gears, controls, wiring, solenoids, hand wheels, levers, chains, and extensions, as applicable.

C. Provide actuators with torque ratings equal to or greater than required for valve seating and dynamic torques, whichever is greater, and capable of holding the valve in any intermediate position between fully-open and fully-closed without creeping or fluttering.

D. Actuator torque ratings for butterfly valves shall be determined in accordance with AWWA C504 - Rubber-Seated Butterfly Valves.

E. Identify wires of motor-driven actuators by unique numbers.

F. Manufacturers

1. Where indicated, certain valves and gates may be provided with actuators manufactured by the valve or gate manufacturer.

2. Where actuators are furnished by different manufacturers, coordinate the selection to result in the fewest number of manufacturers possible.

G. Materials

1. Provide actuators of current models, of the best commercial quality materials, and liberally sized for the required torque.

2. Provide materials suitable for the environment in which the valve or gate is to be installed.

H. Actuator Mounting and Position Indicators

1. Securely mount actuators by means of brackets or hardware specially designed and sized for this purpose and of ample strength.

2. Cast the word "OPEN" on each valve or actuator, with an arrow indicating the direction to open in the counter-clockwise direction.

3. Equip gear and power actuators with position indicators.

4. Where possible, locate manual actuators between 48 and 60 inches above the floor or the permanent working platform.

I. Standards

1. Unless otherwise indicated and where applicable, provide actuators in accordance with AWWA C542 - Electric Motor Actuators for Valves and Slide Gates.

J. Provide fasteners in accordance with the requirements of Section 05 50 00 – Miscellaneous Metalwork.

K. Provide coatings in accordance with the requirements of Section 09 96 00 – Protective Coating.

2.2 MANUAL ACTUATORS

A. General

1. Unless otherwise indicated, provide valves and gates with manual actuators.

2. Provide valves in sizes up to and including 4 inches with direct-acting lever or hand wheel actuators of the manufacturer's best standard design.

3. Provide valves and gates larger than 4-inch with gear-assisted manual actuators, with an operating pull of maximum 60 pounds on the rim of the hand wheel.

4. Provide buried and submerged gear-assisted valves, gates, valves 30 inches in diameter and larger, and where indicated, with worm gear actuators, hermetically-sealed water-tight and grease-packed.

5. Valves 6-inch to 24-inch diameter may be provided with traveling-nut actuators, worm gear actuators, spur or bevel gear actuators, as appropriate for each valve.

B. Buried Valves

1. Unless otherwise indicated, provide buried valves with extension stems to grade, with square nuts or floor stands, position indicators, and cast-iron or steel pipe extensions with valve boxes, covers, and operating keys.

2. Where indicated, provide buried valves in cast-iron, concrete, or similar valve boxes with covers of ample size in order to allow operation of the valve actuators.

3. Permanently label the valve box covers as required by the local Utility Company or the ENGINEER.

4. Provide wrench-nuts in compliance with AWWA C500 - Metal-Seated Gate Valves for Water Supply Service.

C. Floor Boxes

1. Provide hot-dipped galvanized cast iron or steel floor boxes and covers to fit the slab thickness, for operating nuts in or below concrete slabs.

2. For operating nuts in the concrete slab, provide a bronze-bushed cover.

D. Tee Wrenches

1. Furnish buried valves with floor boxes with 2 operating keys or one key per 10 valves, whichever is greater.

2. Size the tee wrenches such that the tee handle will be 2 to 4 feet above ground, and to fit the operating nuts.

E. Manual Worm Gear Actuator

1. Provide an actuator consisting of a single- or double-reduction gear unit contained in a weatherproof cast iron or steel body with cover, and a minimum 12-inch diameter handwheel.

2. Provide the actuator to be capable of a 90-degree rotation, and equip the actuator with travel stops capable of limiting the valve opening and closing.

3. Provide the actuator with spur or helical gears and worm gearing.

4. Provide a self-locking gear ratio in order to prevent "back-driving."

5. Construct the spur or helical gears of hardened alloy steel, and the worm gear of alloy bronze.

6. Construct the worm gear shaft and the hand wheel shaft from 17-4 PH or similar stainless steel.

7. Accurately cut gearing with hobbing machines.

8. Use ball or roller bearings throughout.

9. Provide the output shaft end with a spline in order to allow adjustable alignment.

10. Actuator output gear changes shall be mechanically possible by simply changing the exposed or helical gearset ratio without further disassembly of the actuator.

11. Design gearing for a 100 percent overload.

12. The entire gear assembly shall be sealed weatherproof.

F. Floor Stand Actuators

1. Provide floor stand actuators for gates and valves where indicated. Bodies shall be ductile iron. Handwheel shall be mounted to the top or side and shall include a padlock adapter. Where possible, provide an adapter to allow actuators to be be opened using an impact driver.

G. Design and rate buried gear actuators for buried service, provide with a stainless steel input shaft, and double-seal on shaft and top cap.

PART 3 -- EXECUTION

3.1 SERVICES OF MANUFACTURER

A. Field Adjustments

1. The adjustment of actuator controls and limit switches in the field for the required function shall be performed by field representatives of the manufacturers of valves or gates with pneumatic, hydraulic, or electric actuators.

3.2 INSTALLATION

A. Install valve and gate actuators and accessories in accordance with the requirements of Section 43 30 00 – Valves, General.

B. Locate the actuators to be readily accessible for operation and maintenance without obstructing walkways.

C. Do not mount actuators where shock or vibrations will impair their operation, and do not attach the support systems to handrails, process piping, or mechanical equipment.

END OF SECTION

SECTION 43 30 14 - BUTTERFLY VALVES

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide butterfly valves and appurtenances, complete and operable, in accordance with the Contract Documents. Where indicated, salvage and reinstall existing butterfly valves.

B. The requirements of Section 46 01 00 – Equipment General Provisions apply to this Section.

C. The requirements of Section 43 30 00 - Valves, General apply to this Section.

D. The requirements of Section 43 30 12 - Valve and Gate Actuators apply to this Section.

E. Butterfly valve installation to HDPE pipe may require valve spacers or beveled HPDE flanges or adapters.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 43 30 00 – Valves, General.

B. Shop Drawings

1. Complete Shop Drawings of butterfly valves and actuators.

2. Drawings showing valve port diameter complete with dimensions, part numbers, and materials of construction.

3. Dynamic seating and unseating torque for motor actuated valves.

4. Certified statement of proof-of-design tests from the valve manufacturer. Valve manufacturer shall state that the valves proposed for this project will be manufactured with identical basic type of seat design and materials of construction to the prototype evaluated under the proof of design testing.

5. Manufacturer's certification that the valve complies with applicable provisions of AWWA C504 – Rubber-Seated Butterfly Valves.

1.3 QUALITY ASSURANCE

A. Valves shall be subjected to performance, leakage, and hydrostatic tests in accordance with procedures and acceptance criteria established by AWWA C504.

PART 2 -- PRODUCTS

2.1 RUBBER SEATED BUTTERFLY VALVES 25 TO 150 PSI (AWWA)

A. General: Butterfly valves for steady-state water working pressures and steady-state differential pressure up to 150 psi and for freshwater service having a pH range from 6 to 10 and temperature range from 33 to 125 degrees F shall conform to AWWA C504 and be as indicated. Valves subjected to steady state working pressures and steady state differential pressures from 25 to 150 psi in sizes 3-inches through 24-inches shall be rated for Class 150B with actuator sized for Class 150B. Valves 30 inches through 72-inches

shall be of the class indicated. Valves larger than 72-inches shall be of the class indicated, designed in accordance with the intent of AWWA C504. If the operating conditions such as flow, velocity, and differential pressures are not indicated, the valve body and shaft shall be sized for the pressure class rating of the valve.

B. Valves shall be of the body type, pressure class, end joint, and actuator indicated.

C. Construction: Unless otherwise indicated, materials of construction shall be in accordance with AWWA C504, suitable for the service. Seats shall be positively clamped or bonded into the disc or body of the valve, but cartridge-type seats that rely on a high coefficient of friction for retention shall not be acceptable. Seat material shall be guaranteed to last for at least 75 percent of the number of cycles in the AWWA C504 proof-of-design test without premature damage.

Description	Material Standards
Valve bodies	Gray iron, ASTM A 48, Class 40 or Gray iron, ASTM A 126, Class B, or Ductile iron, ASTM A 536, grade 65-45-12 or 70-50-05
End flanges	Same material as valve bodies
Valve shafts	Stainless steel ASTM A 240 or A 276, Type 316
Valve discs	Same material as valve bodies.
Rubber seats	New natural or synthetic rubber
Seat mating surfaces	Stainless steel, ASTM A 240 or A 276, Type 316
Clamps and retaining rings	Type 316 retaining rings and cap screws.
Valve bearings	Self-lubricating materials per AWWA C504
Shaft seals	Resilient non-metallic materials suitable for service
Painting and coating	Refer to Section 09 96 00 – Protective Coating

D. Manual Actuators: Unless otherwise indicated, manually actuated butterfly valves shall be equipped with a handwheel and 2-inch square actuating nut and position indicator. Screw-type (traveling nut) actuators will not be permitted for valves 30-inches in diameter and larger.

E. Worm Gear Actuators: Buried valves shall be equipped with worm-gear actuators, lubricated and sealed to prevent entry of dirt or water into the housing.

F. Manufacturers, or Equal

1. **DeZURIK Water Controls, Corporation**

2. **Kennedy Valve**

3. **M & H Valve Company**

4. **Mueller Company**

5. **Henry Pratt Company**

6. **Rodney Hunt Company** (24-inches and larger)

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Exposed butterfly valves shall be installed with a means of removing the complete valve assembly without dismantling the valve or operator. Installation shall be in accordance with Section 43 30 00 – Valves, General.

END OF SECTION

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SECTION 43 30 16 - CHECK VALVES

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide check valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 43 30 00 - Valves, General apply to this Section.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 43 30 00 – Valves, General.

PART 2 -- PRODUCTS

2.1 SWING CHECK VALVES (2-INCHES AND LARGER)

A. General: Swing check valves for water, sewage, sludge, and general service shall be of the outside lever and spring or weight type, in accordance with AWWA C 508 - Swing-Check Valves for Waterworks Service, 2-in. through 24-in. NPS, unless otherwise indicated, with full-opening passages, designed for a water-working pressure of 150 psi. Units shall have a flanged cover piece to provide access to the disc. Where indicated, swing check valves shall be provided with position indicators.

B. Body: The valve body and cover shall be of cast iron conforming to ASTM A 126 - Gray Iron Castings for Valves, Flanges, and Pipe Fittings, with flanged ends conforming to ASME B 16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800, or be mechanical joint ends, as indicated.

C. Disc: The valve disc shall be of cast iron, ductile iron, or bronze conforming to ASTM B 584 - Copper Alloy Sand Castings for General Applications.

D. Seat and Rings: The valve seat and rings shall be of bronze conforming to ASTM B 584 or B 148 - Aluminum-Bronze Castings or of Buna-N.

E. Hinge Pin: The hinge pin shall be of bronze or stainless steel.

F. Manufacturers, or Equal

1. **APCO (Valve and Primer Corp.)**
2. **Kennedy Valve**
3. **Mueller Company**
4. **Stockham Valves and Fittings**
5. **Golden Anderson**

2.2 FLANGED RUBBER CHECK VALVES

A. General: Rubber check valves shall be duckbill style and fully passive. Valves shall be of standard neoprene construction and designed to bolt directly to an ANSI 150# standard flange of the size indicated. The valve shall have a low cracking pressure of no more than 3 inches of water head. Provide a stainless-steel retaining ring for connection to the flange.

B. Manufacturers, or Equal

1. Proco Style 710 ProFlex

PART 3 -- EXECUTION

3.1 GENERAL

A. Valves shall be installed in accordance with provisions of Section 43 30 00 - Valves, General.

END OF SECTION

SECTION 43 30 18 - BALL VALVES

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide ball valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 43 30 00 - Valves, General apply to this Section.

C. The requirements of Section 43 30 12 - Valve and Gate Actuators apply to this Section.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Sections 01 33 00 – Contractor Submittals and 43 30 00 - Valves, General.

PART 2 -- PRODUCTS

2.1 METAL BALL VALVES (4-INCHES AND SMALLER)

A. **General:** Unless otherwise indicated, general purpose metal ball valves in sizes up to 4-inches shall have actuators in accordance with Section 43 30 12 - Valve and Gate Actuators.

B. **Body:** Valves 1-inches to 4-inches in size shall have bronze or carbon steel 2 or 3 piece bodies with flanged ends for a pressure rating of ANSI 125 psi or 150 psi unless otherwise indicated.

C. **Balls:** The balls shall be solid chrome-plated brass or bronze, or stainless steel, with standard port (single reduction) or full port openings.

D. **Stems:** The valve stems shall be of the blow-out proof design, of bronze, stainless steel, or other acceptable construction, with reinforced teflon seal.

E. **Seats:** The valve seats shall be of teflon or Buna-N, for bi-directional service and easy replacement.

F. Manufacturers, or Equal

1. **Conbraco Industries, Inc. (Apollo)**
2. **ITT Engineered Valves**
3. **Neles-Jamesbury, Inc.**
4. **Watts Regulator**
5. **Worcester Controls**

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PART 3 -- EXECUTION

3.1 GENERAL

A. Valves shall be installed in accordance with Section 43 30 00. Care shall be taken that valves in plastic lines are well supported at each end of the valve.

END OF SECTION

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SECTION 43 30 30 – ECCENTRIC PLUG VALVES

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall provide plug valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 43 30 00 – Valves and Gates, General apply to this Section.

C. The requirements of Section 43 30 12 – Valve and Gate Actuators apply to this Section.

D. Plug valves shall have undergone a proof-of-design test to demonstrate that the valve components operate at the service flow, pressure, temperature, and fluid conditions, free from binding, excessive noise, and premature failures. Proof-of-design test results shall be available to the engineer on request. The proof-of-design test shall be conducted in accordance with the applicable provisions of AWWA C504.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Contractor Submittals.

PART 2 -- PRODUCTS

2.1 FULL PORT ECCENTRIC PLUG VALVES (1/2-INCH TO 72-INCHES)

A. **Construction:** Eccentric plug valves shall be of the non-lubricated, eccentric plug design with 316L stainless steel bodies, Flanges, and Pipe Fittings, with ANSI 125 lb. flanged ends for valves 3-inches and larger, and screwed or flanged ends for smaller sizes. The plugs and shafts shall be of cast iron or ductile iron conforming to ASTM A 536 – Ductile Iron Castings, and the plugs shall be lined with a resilient coating, best suited for the specific service. The body shall be lined with a suitable elastomer, where required for a special service. The seats shall be of stainless steel welded to the body. Top and bottom shaft bearings shall be of permanently lubricated stainless steel or Teflon coated stainless steel. Grit seals of Teflon, Nylatron, or similar suitable material shall be at the top and bottom plug journals. Valves up to and including 20-inches in size shall have an unobstructed port area of not less than 100 percent of full pipe area, and not less than 70 percent for larger valves. Eccentric plug valves shall have a pressure rating of not less than 150 psi WOG, for bubble-tight shut-off in the standard flow direction, and 25 psi WOG in the reverse flow direction. When equipped with worm gear actuator, the pressure rating shall be 150 psi WOG in both directions. The stem seal shall consist of field adjustable packing, replaceable without removal of the actuator, or of self-adjusting U-cup packing.

B. **Actuators:** Unless otherwise indicated, eccentric plug valves 3-inches and smaller shall have operating levers; larger valves shall have worm-gear actuators. Valve actuators shall be in accordance with Section 43 30 12.

C. Manufacturers, or Equal:

1. DeZurik Corporation

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Plug valves shall be installed in strict accordance with the manufacturer's published recommendations and the applicable provisions of Section 43 30 00.

B. **Eccentric Plug Valves:** Unless otherwise directed, the following rules shall be observed for the installation of eccentric plug valves:

1. The valves shall be positioned with the stem in the horizontal direction.

2. In horizontal pipelines, the plug shall swing upwards when opening, to permit flushing out of solids.

3. The orientation of the valve shall prevent the valve body from filling up with solids when closed; however, where the pressure differential through the valve exceeds 25 psi, the higher pressure for valves without worm gear, electric, or air operators shall be through the valve to force the plug against the seat.

4. Valves which may be closed for extended periods (stand-by, bypass, or drain lines) and valves with reversed flow (higher pressure on downstream side, forcing the plug away from its seat), shall be equipped with worm gear operators for the full range of sizes.

5. For special applications or when in doubt, consult with the manufacturer prior to installation.

END OF SECTION

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SECTION 43 30 52 - MISCELLANEOUS VALVES

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide miscellaneous valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 43 30 00 - Valves, General, apply to this Section.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 43 30 00 - Valves, General.

PART 2 -- PRODUCTS

2.1 ALFALFA VALVE

A. Alfalfa valves shall be of the size indicated on the Contract Drawings. The valve body and cover shall be cast iron with a brass nut and washer. The screw shall be bronze. The valves shall be capable of connecting to HDPE pipe.

B. Manufacturers, or Equal

1. **McWane Plant and Industrial**

2.2 AIR-VACUUM AND AIR-RELEASE VALVES

A. Air and Vacuum Valves: Air and vacuum valves shall be capable of venting large quantities of air while pipelines are being filled and allowing air to re-enter while pipelines are being drained. They shall be of the size indicated, with flanged or screwed ends to match piping. Bodies shall be of high-strength cast iron. The float, seat, and moving parts shall be constructed of Type 316 stainless steel. Seat washers and gaskets shall be of a material insuring water tightness with a minimum of maintenance. Valves shall be designed for minimum 150 psi water-working pressure, unless otherwise indicated.

B. Air-Release Valves: Air-release valves shall vent accumulating air while system is in service under pressure and be of the size indicated. Valves shall meet the same general requirements as indicated for air and vacuum valves except that the vacuum feature will not be required. Valves shall be designed for a minimum water-working pressure of 150 psi, unless otherwise indicated.

C. Combination Air Valves: Combination air valves shall combine the characteristics of air and vacuum valves and air release valves by exhausting accumulated air in systems under pressure and releasing or re-admitting large quantities of air while a system is being filled or drained, respectively. Valves shall have the same general requirements as indicated for air and vacuum valves.

D. Manufacturers, or Equal

1. **APCO (Valve and Primer Corporation)**

2. **Crispin - Multiplex Manufacturing Company**

3. **GA Industries**

4. **Val-Matic (Valve and Manufacturing Corporation)**

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Valves shall be installed in accordance with the manufacturer's printed recommendations, and with Section 43 30 00 – Valves, General.

B. Air and vacuum release valves shall have piped outlets to the nearest acceptable drain, firmly-supported, and installed in such a way as to avoid splashing and wetting of floors and obstruction of traffic.

END OF SECTION

SECTION 43 30 62 - SLIDE GATES AND WEIR GATES

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide slide gates, complete and operable, in accordance with the Contract Documents.

B. See equipment schedules for summary of gate quantities, sizes, and operator requirements. Select gates are downward opening type.

C. The requirements of Section 01 33 00 – Contractor Submittals apply to this section.

D. Single Manufacturer

1. The CONTRACTOR shall assign to a single manufacturer responsibility for the furnishing and functional operation of the hydraulic gates, including operators and accessories.

2. The designated single manufacturer, however, need not manufacture more than one part of the units, but shall coordinate the design, assembly, testing, and installation of the units.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

AWWA C513	Open-Channel, Fabricated-Metal Slide Gates and Open-Channel, Fabricated-Metal Weir Gates
AWWA C561	Stainless Steel Slide Gates
AWWA C562	Aluminum Slide Gates
ASTM B 21	Naval Brass Rod, Bar, and Shapes
ASTM B 584	Copper Alloy Sand Castings for General Applications

1.3 CONTRACTOR SUBMITTALS

A. Shop Drawings

1. Submit the following:

a. Drawings of gates, frames, slides, and actuators

b. Design load calculations for deflection at the maximum expected head

c. Calculations for the lifting force generated by 40 pounds effort on the handwheel or crank in order to operate the gate.

d. Technical data for over-torque protection fitting(s)

B. Technical Manuals

1. Submit complete technical manuals, including printed instructions for proper maintenance, lubrication, and complete parts list indicating the various parts by name, number, and exploded view where necessary.

C. Field Procedures

1. Prior to installation of the gates, provide instructions for field procedures for installation, adjustments, inspection, and testing.

2. Utilize the manufacturer's anchor bolt template to install anchor bolts at all locations.

1.4 QUALITY ASSURANCE

A. The leakage allowance for slide gates under the design seating and unseating heads shall conform with the AWWA Standards listed above.

B. Factory Testing

1. Gates shall be factory-assembled and functionality-tested prior to delivery to the Site.

C. Equipment Field Testing

1. The CONTRACTOR shall be responsible for the coordination of tests of each hydraulic gate in the presence of the manufacturer's factory service representative.

2. Excessive leaks shall be corrected and the equipment retested until found to be satisfactory.

1.5 WARRANTY

A. The CONTRACTOR shall furnish the manufacturer's written guarantee that the hydraulic gates comply with the indicated requirements.

B. The CONTRACTOR shall furnish the manufacturer's warranties as published in its literature.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Gates shall comply with the following Standards:

1. AWWA C513 Open-Channel, Fabricated-Metal
Slide Gates and Open-Channel, Fabricated-Metal Weir Gates

2. AWWA C501 Standard for Sluice Gates

3. AWWA C562 Aluminum Slide Gates

4. AWWA C561 Stainless Steel Slide Gates

B. Gates shall be new and of current manufacture, adequately braced in order to prevent warpage and bending under the intended use. Indicated and necessary mountings and appurtenances shall be included.

C. Gate actuators shall be sized, selected, and furnished by the gate manufacturer.

D. Gate actuators throughout the project shall be products of a single manufacturer.

E. Mounting Requirements

1. Guide frames shall be extended 3 feet, 6 inches above the wall or walkway in order to match the height of the handrail.

2. Where a gate is mounted in an opening between 2 sections of handrail, additional horizontal members shall be added to the gate frame to match the handrail, guardrail, and kickplate spacing of the adjacent railing.

3. Horizontal members shall be arranged such that the railing will not interfere with operation of the actuator.

2.2 ALUMINUM SLIDE GATES

A. Construction

1. Unless otherwise indicated, materials of construction shall be in accordance with AWWA C513, C501, and C562 suitable for the service.

2. Materials used in the fabrication of the slide gates shall conform to the requirements of the standards designated for each material as indicated below:

Description	Material Standards
Aluminum Gates	
Slide	Aluminum, ASTM B 209 Alloy 6061-T6
Frame	Aluminum ASTM B 308 Alloy 6061-T6
Stem and coupling	ASTM A 276, Type 316
Hardware	ASTM A 276, Type 316
Stem Cover	Clear polycarbonate cylinders
Guides and seats	UHMW Polyethylene, ASTM D 4020
Seals	“J” bulb Type, Neoprene, ASTM D 2000

2.3 STAINLESS STEEL SLIDE GATES

A. Construction

1. Unless otherwise indicated, materials of construction shall be in accordance with AWWA C513, C501 and C561 suitable for the service.

2. Materials used in the fabrication of the slide gates shall conform to the requirements of the standards designated for each material as indicated below:

Description	Material Standards
Stainless Steel Gates	
Slide	ASTM A 276, Type 316
Frame	ASTM A 276, Type 316
Stem and coupling	ASTM A 276, Type 316
Hardware	ASTM A 276, Type 316
Stem Cover	Clear polycarbonate cylinders
Guides and seats	UHMW Polyethylene, ASTM D 4020
Seals	"J" bulb Type, Neoprene, ASTM D 2000

B. Lifting Devices

1. Provide lifting devices complete with stem, lifting nut, intermediate supports with steady bushings, stem cover, indicator, and gear reducer, hand wheel, crank, valve nut, electric or hydraulic cylinder, where indicated.

2. The lifting devices shall be weatherproof.

3. Lift Assembly Mounting

   a. The lifting devices shall be yoke-mounted and the operator housing constructed of cast iron or fabricated steel.

      1) The centerline of the manual actuator for all gates except 3-G-6 shall be approximately 3 feet above the floor or grating elevation.

      2) The centerline of the manual valve nut actuator for gate 3-G-6 shall be located 6-inches below the grating.

4. Power lifting devices shall be in accordance with Section 43 30 12 – Valve and Gate Actuators.

5. Slide gate hoist heads shall be constructed of cast iron.

6. The operating nut shall be constructed of solid bronze, in accordance with ASTM B 584.

7. Operating thrust shall be taken on roller or ball bearings.

8. Parts shall be provided with an alternative lubrication system.

9. Handwheel or Crank

    a. The unit shall be designed for a 40–pound maximum effort on the crank in order to operate the gate.

    b. Clockwise movement of the handwheel shall close the gate.

    c. The operating crank shall be easily removable in order to facilitate the use of a portable power operator.

10. One removable Over-torque protection fitting shall be provided with a trip torque setting which has been calibrated at the factory and set for the industry practice torque limit for the slide gates.

C. Manufacturers, or Equal

1. **Whipps Gates**

2. **Golden Harvest, Inc.**

3. **Rodney Hunt Company**

4. **Aunspach Controls**

2.4 HARDWARE

A. Bolts and nuts shall comply with the requirements of Section 05 50 00 – Miscellaneous Metalwork.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Slide gates shall be installed in strict accordance with the manufacturer's printed recommendations and the indicated requirements.

B. Operators shall be located as to avoid interference with handrails and structural members.

C. Damage to surface coatings incurred during shipment or installation shall be repaired using the manufacturer’s recommended coating.

END OF SECTION

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SECTION 43 30 67.39 – PRESSURE REGULATING VALVE

PART 1 -- GENERAL

1.1 SUMMARY

A. The Contractor shall provide pressure sustaining valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 43 30 00 – Valves, General apply to this Section.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

40 05 51	Common Requirements for Process Valves

B. Reference Standards

ASME B16.1	Cast Iron Pipe Flanges and Flanged Fittings
ASME B16.42	Ductile Iron Pipe Flanges and Flanged Fittings
ASTM A 48	Gray Iron Castings
ASTM A 126	Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A 536	Ductile Iron Castings
ASTM B 62	Composition Bronze or Ounce Metal Castings

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 43 30 00 – Valves, General.

1.4 SPECIAL WARRANTY REQUIREMENT

A. The valve shall be warranted for a period of 3 years from the date of shipment to be free of defects in materials and workmanship.

PART 2 -- PRODUCTS

2.1 FLANGED PRESSURE RELIEF VALVES, SIZES 1-1/2 INCHES THROUGH 42-INCHES

Valve Characteristics: The Pressure Relief/Sustaining Control Valve shall maintain a constant upstream pressure by bypassing or relieving excess pressure and shall maintain close pressure limits without causing surges. Valves will remain closed until the upstream pressure exceeds a pre-determined set point. Valves will be fast opening and modulate to limit the upstream pressure to a pre-determined set point. If upstream pressure decreases below the pilot spring setting, the valve shall close. Valves will be slow closing to prevent surges.

A. Valve Body: The valve body shall be of ductile iron to ASTM A 536 - Ductile Iron Castings, with flanged ends to ASME B16.42 - Ductile Iron Pipe Flanges and Flanged Fittings. The valve cover shall be flanged and be of the same material as the body.

B. Valve Trim: The valve stems, springs, body seat rings, and bolts, nuts, and washers shall be of Type 302, 303, or 316 stainless steel. The valve stems shall have top and bottom guides. Rubber parts shall be Buna-N. The diaphragms shall be of Nylon-reinforced Buna-N, supported firmly between body and valve cover. The valve pistons and piston liners shall be bronze to ASTM B 62 - Composition Bronze or Ounce Metal Castings.

C. Valve Controls: The valve shall be furnished with a complete, externally mounted control system, including adjustable speed control needle valves, strainer, and necessary copper or stainless-steel connecting tubing and fittings. The controls shall be capable of achieving the flow and speed adjustment indicated.

D. Factory Tests: Valves shall be factory tested with a hydrostatic test and a functional test and a test certificate shall be submitted to the Engineer prior to delivery of the valve.

E. Operating Conditions: The valve shall be designed to operate under the following conditions:

Total flow from pump station, gpm	2,250
Maximum inlet pressure, psi	25
Maximum flow through valve, gpm	2,250
Valve size, in	8
Diameter of pipeline, in	10

F. Spare Parts: The following spare parts shall include:

1. One complete set of resilient seals and discs

G. Manufacturers, or equal

1. Cla-Val Company

2. Golden-Anderson

3. OCV Control Valves

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Valves shall be installed in accordance with provisions of Section 43 30 00 – Valves, General.

3.2 SERVICES OF MANUFACTURER

A. Inspection, Startup, and Field Adjustment: The service representative of the valve manufacturer shall be present at the Site for 1 Day, to assist the Contractor in the installation and adjustment of the valve(s).

B. Instruction of Owner's Personnel: The training representative of the valve manufacturer shall be present at the Site for 4 hours to instruct the personnel in the operation, adjustment, and maintenance of the valve(s).

C. For the purpose of this paragraph, a Day is defined as an 8-hour period, excluding travel time.

END OF SECTION

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SECTION 43 52 04 – MAINTENANCE HOISTS AND WINCHES

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. Furnish all materials, equipment, labor, training, and field testing to install, complete four stationary electric winches and a single maintenance hoist and monorail system, in accordance with the Contract Documents. The winches and maintenance hoist to be furnished and installed along with their general characteristics is listed in Paragraph 2.01.A of this specification section.

Hoist or Winch Type	Number of Units	Lifting Method	Capacity (Tons)
Wire Rope Stationary Winch	4	Electric	0.375
Wire Rope Chain Operated Gear Driven Manual trolley	1	Manual	0.5

B. The CONTRACTOR shall familiarize themselves with the locations and functions of the winches and hoist prior to preparing submittals for the equipment.

C. The requirements of the following sections apply to this Section:

1. Section 01 33 00 – Contractor Submittals

2. Section 09 96 00 – Protective Coating

3. Section 46 01 00 – Equipment General Provisions

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Hoist and winch systems shall be designed, manufactured, and tested in accordance with the pertinent provisions of the following codes and standards. Other equivalent well recognized international standards may be substituted where necessary.

1. AISC Specification, "Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings;"

2. AGMA, "American Gear Manufacturers Association;"

3. ANSI/ASME HST-4 "Performance Standard for Electric Wire Rope Hoists"

4. ASTM A 307, "Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength;"

5. ASTM A 325, "Specification for Structural Bolts, Steel Heat Treated,120/105 ksi minimum Tensile Strength;"

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6. ASTM A 490, "Specification for Structural Bolts, Alloy Steel, Heat-Treated, 150 ksi Minimum Tensile Strength;"

7. CMAA Specification No.74, "Specifications for Electric Overhead Traveling Cranes;"

8. NEMA ICS, "Industrial Controls and Systems;"

9. NEMA MG 1, "Motors and Generators;"

10. NFPA 70, "National Electrical Code;"

11. OSHA, "Occupational Safety and Health Administration;"

12. SSPC-PA 1, "Shop, Field, and Maintenance Painting;" and

13. SSPC-SP 6, "Commercial Blast Cleaning."

1.3 ACCEPTABLE MANUFACTURERS

A. The manufacturer for the design and fabrication of the maintenance hoists shall have been in the business of designing and fabricating similar equipment of comparable size for no less than 10 years and shall have at least 5 working installations for not less than 5 years.

1.4 SUBMITTAL CONTENT

A. Hoist and winch manufacturer's qualifications.

B. Furnish Shop Drawings and Manufacturer documents containing the following information:

1. Hoist and Trolley manufacturer, model, and type;

2. Winch manufacturer, model, and type;

3. General clearance diagrams which shall show pertinent final dimensions, final weights;

4. Complete layout of the equipment supplied with rope and hook;

5. Descriptive literature and materials specifications;

6. Hoist monorail sizing and connection calculations stamped by a professional engineer registered in the State of Washington;

7. Assembly and internal details of hoist and winches including showing brake motor, planetary gear reductions, number of teeth of gears, and drum dimensions;

8. Electrical motor manufacturer, description, power rating, speed, and insulation;

9. Description and ratings of brakes/brake motor;

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10. Electrical data including minimum circuit ampacity and maximum overcurrent protection, control and wiring diagrams, electrical characteristics, protective devices, and connection requirements.

11. Lists of all hoist and winch nameplates and all caution, warning, and control nameplates;

C. Catalog pages describing other components as required, for clarity, circle or highlight relevant information and/or omit or cross out features and options not proposed.

D. Manufacturer's quality control procedures.

E. Recommended spare parts, including ordering information and a current price list.

F. Manufacturer's storage and assembly information.

G. Terms of the warranty.

H. Manufacturer Operation and Maintenance Manuals

I. Test Data – submit quality control data prior to shipping the equipment.

1.5 STRUCTURAL DESIGN

A. **Structural Design:** The structural design shall consider, as a minimum, the following loads:

1. Wind Load**:** The wind load shall be calculated in accordance with ASCE 7-16.

1.6 QUALITY ASSURANCE

1.7 Establish, maintain, and document quality control.

1.8 DELIVERY, HANDLING, AND STORAGE

A. All equipment shall be factory assembled to the extent possible prior to shipment.

B. Equipment parts unable to be factory assembled shall be furnished with an assembly plan and instructions. Separate parts and assemblies shall be match-marked or tagged in a manner to facilitate assembly.

C. Removable protective coating shall be provided to protect machined and unpainted parts subject to damage during delivery, handling, and storage.

D. Equipment shall be packaged or crated in a manner that will provide protection from damage during shipping, handling, and storage.

1. Packages and crates shall be adequately marked or tagged to indicate contents by equipment name, contract number and equipment number, approximate weight, any special precautions for handling and recommended requirements for storage, as required.

2. Equipment shall be stored in a weatherproof container in accordance with the manufacturer's instructions.

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E. All equipment and material shall be delivered to the Site.

F. All equipment and materials shall be unloaded at the point of delivery based on written unloading, handling, and storage instructions.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Supply the following Hoist and Winch Systems:

Equip. No.	Name	Type	Capacity (Tons)	Remarks
ME-5	Lower Raceway Drain End No.1	115V, Single Phase Electric Winch Stainless Steel Cable	0.375	Horizontal Orientation
ME-6	Lower Raceway Drain End No. 2	115V, Single Phase Electric Winch Stainless Steel Cable	0.375	Horizontal Orientation
ME-7a	Lower Rearing Pond Drain End No. 1	115V, Single Phase Electric Winch Stainless Steel Cable	0.375	Horizontal Orientation
ME-7b	Lower Rearing Pond Drain End No. 2	115V, Single Phase Electric Winch Stainless Steel Cable	0.375	Horizontal Orientation
MS-1	North Lower Raceway Crowder Scraper Leaf	115V, Single Phase Electric Hoist Stainless Steel Cable	0.5	Horizontal Orientation
MS-2A	Lower Pond Crowder Scraper Leaf	115V, Single Phase Electric Hoist Stainless Steel Cable	0.5	Horizontal Orientation
MS-2B	Lower Pond Crowder Scraper Leaf	115V, Single Phase Electric Hoist Stainless Steel Cable	0.5	Horizontal Orientation
MS-2C	Lower Pond Crowder Scraper Leaf	115V, Single Phase Electric Hoist Stainless Steel Cable	0.5	Horizontal Orientation
MS-3	South Lower Raceway Crowder Scraper Leaf	115V, Single Phase Electric Hoist Stainless Steel Cable	0.5	Horizontal Orientation

A. Drive Trains and Service Factors: Service factors shall be applied in the selection or design of mechanical power transmission components. Components of drive train assemblies between the prime mover and the driven equipment shall be designed and rated to deliver the maximum peak or starting torque (whichever is the greatest), speed,

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and horsepower. Applicable service factors shall be considered, such as mechanical (type of prime mover), load class, start frequency, ventilation, ambient temperature, and fan factors. Drive train components include couplings, shafts, gears and gear drives, drive chains, sprockets, and V-belt drives. Unless otherwise indicated, the following load classifications shall apply in determining service factors:

Type of Equipment	Service Factor	Load Classification
Hoists/Winches	1.25	Moderate Shock

B. Protective Coating: Hoist and hoist components shall be coated using a manufacturer's standard coating systems rated for outdoor installation and service. Winch and winch components shall be coated using a manufacturer's standard coating systems rated for outdoor installation and service. Coating color shall be determined by OWNER. All bolts shall be hot-dip galvanized.

C. Components: Fasteners, quick release pins, bearings, balls, spools, hooks, and wire rope shall be stainless steel.

D. Protection of Equipment:

1. Machined and coated surfaces shall be protected by rust inhibitor material prior to shipment.

2. Equipment shall be protected from exposure and kept thoroughly dry. Equipment having anti-friction or sleeve bearings shall be stored in weathertight storage facilities prior to installation. For extended storage periods, plastic equipment wrappers may need to be avoided to prevent accumulation of condensate in gears and bearings.

3. Equipment with anti-friction bearings or sleeve bearings shall be protected from being damaged due to jarring motion during shipment.

4. Equipment delivered to the Site with rust or corroded parts shall be rejected. If equipment develops defects during storage, it shall be disassembled, cleaned, recoated, or otherwise corrected to restore it to original condition.

E. Identification of Equipment Items

1. At the time of shipping, each item of equipment shall have a legible identifying mark corresponding to the equipment number in the Contract Documents for the particular item.

2. After installation, each item of equipment shall be given permanent identification.

2.2 MAINTENANCE HOISTS AND WINCHES

A. Requirements

1. The maintenance hoist requirements shall be as listed in Paragraph 2.1.A of this specification and as listed below.

B. Site Conditions

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Equipment No	All maintenance hoists and winches
Atmosphere	Outdoors Saltwater Rain Sun
Operation	Intermittent

C. Maintenance Hoists

1. Type: Packaged, wire rope chain operated hoist, under-hung type with gear driven manual trolley.

2. Design: Simple and sturdy design. The hoist shall be suitable for outdoor use in permanently moist environments.

3. Hoist Operating Speed: Manual

4. Trolley Travel Speed: Manual

5. Minimum Lift: 20 ft.

6. Travel Limits: End stops on the monorail.

7. Wire Rope: Stainless steel, three (3) wraps minimum remaining on drum with hook in the lowest position.

8. Hoist Motor: N/A

9. Monorail: The monorail for the fish screen hoist shall be a structural S-shape sized by the hoist supplier to accommodate the gear driven hoist trolley and the monorail support column layout. The monorail sizing and connection details to the supports shall designed by the hoist supplier or a designer hired by the hoist supplier. Calculations for the monorail sizing and connections to the structural support columns shall be prepared by a professional engineer registered in the State of Washington and shall be submitted for review and approval.

D. Maintenance Hoist Control:

1. The hoist shall be chain operated for raising and lowering the hook and a separate chain for traversing the gear driven trolley back and forth along the monorail.

E. Hoist Manufacturers, or Equal:

1. Columbia Winch and Hoist

2. Coffing Hoists

3. Harrington Hoist

4. Stahl Crane Systems

5. Yale Hoist

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F. Winches:

1. Type: Packaged, wire rope electrically powered hoist.

2. Design: Simple and sturdy design. The hoist shall be suitable for outdoor use in permanently moist saltwater environment with 100% humidity and exposure to rain and sun.

3. Hoist Operating Speed: Variable – 12 to 22 fpm

4. Minimum Lift: 10 ft.

5. Travel Limits: Limit switches on the winch drum.

6. Wire Rope: Stainless steel, three (3) wraps minimum remaining on drum with hook in the lowest position.

7. Hoist Motor: 115 Volt, Single Phase, Severe Duty TEFC Motor

G. Winch Control:

1. Each winch shall have speed and directional control at the winch itself and a pendent containing directional control buttons.

H. Winch Manufacturers, or Approved Equal:

1. Wintech Model WK1500-12-8-V

2. Ingersoll Rand

PART 3 -- EXECUTION

3.1 FIELD ASSEMBLY AND ERECTION

A. General: All equipment shall be assembled and installed in accordance with the applicable Drawings; written instructions of the manufacturer; and applicable codes, standards, and specifications.

3.2 FIELD TESTING

A. General: Test the hoist and winches in the presence of the ENGINEER and the OWNER. The CONTRACTOR'S written instructions shall be used as a general guide. The tests shall include, but not be limited to, those specified herein.

B. Preliminary Checks: The equipment shall be examined for proper field assembly and damage during shipment. In particular, it shall be checked for rain or moisture damage inadequate painting, and accumulations of dirt and rubbish.

C. No Load Static Tests.

1. All gearing, bearings, couplings, and rotating parts shall be checked for proper oil level or lubrication.

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2. The controller for each motion shall be checked to ensure that hook and travel motions agree with marked controller directions.

D. No Load Operation Test.

1. Manual Operation: The hoists shall be operated at least twice in both the hoisting and lowering direction for the full length of the hook lift. The hoist trolley shall be run in each direction of travel for at least two complete cycles of trolley travel to disclose any tendency toward noisy operation and misalignment at bearings or gearing. The motion of the trolleys upon setting the controller to the “off” position shall be checked to determine whether the travel brake correctly stops the trolleys.

2. Electric Operation:

a. Winches shall be operated until the limit switch stops travel. Both upper and lower limit switches shall be checked for proper setting (for resulting hook elevation and amount of rope remaining on drum after switch stops travel) and operation.

b. The additional over travel limit switches shall be checked by temporarily bypassing the action of the normal upper limit switch.

c. The winches shall be checked to determine whether the hook operates within the specified maximum speed ranges. At least two complete raising and lowering operations shall be made for each winch.

d. Proper alignment, quiet operation, and any major tendency toward overheating of motors, bearings, and gear drives shall be checked.

e. Winch brakes shall be checked to determine whether they are functioning properly.

f. All hook approaches, including the end approaches, shall be checked for conformance to approved shop drawings and the requirements of these Specifications. The limit switches shall allow the specified hook approaches or better.

E. Rated Load Test.

1. Manual Operation: The hoists loaded to their rated capacity, shall be operated at least twice in both the hoisting and lowering direction for the full length of the hook lift. Trolley Travel. As applicable, the tests outlined above shall be repeated for the trolley travel, with the hoists loaded to their rated capacity.

2. Electrical Operation:

a. With the winches loaded to their rated capacity, the tests outlined under no load operation test above shall be repeated except that the additional block operated over travel limit switch operation need not be rechecked.

b. The operation of the brakes shall be carefully checked. All components shall be checked for overheating. Each winch shall be checked for overheating after completing the hoisting and lowering cycle with the test load.

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c. Operating speed on the maximum speed point shall be checked and recorded. The control system shall be checked for proper operation.

d. The loaded winches shall be checked to determine whether the winch controls satisfactorily control the handling of the load. The winches must demonstrate its ability to raise, lower, and hold the rated load in any position.

3. Trolley Travel. As applicable, the tests outlined above shall be repeated for the trolley travel, with the hoists loaded to their rated capacity.

END OF SECTION

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SECTION 43 52 10 – PORTABLE DAVIT CRANE AND HOIST

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide one (1) manual davit crane, complete and operable, in accordance with the Contract Documents. The davit crane is intended to be dual purpose, the first for lifting the existing fish ladder entrance bar screen screen near the base of the fish ladder and the second for removing the tailrace diffuser screen.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Contractor Submittals.

B. Technical manuals in accordance with Section 01 77 00 – Closeout Procedures.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Requirements

1. The davit crane shall be a portable hand operated unit for mounting in a flush base embedded in a concrete pedestal and a wall-mount base attached to a concrete wall. Provide two pedestal bases. The first pedestal base will be mounted to a pillar near the base of the fish ladder as shown in the structural drawings. The second pedestal base will be wall-mounted in the downstream side of the south lower raceway for removing the tailrace diffuser screen, see mechanical drawings.

B. Site Conditions

Equipment No	ME-8
Location	Fish Ladder Entrance Screen/Tailrace Diffuser Screen
Atmosphere	Outdoors

C. Construction: The davit cranes shall be designed as follows:

1. Galvanized steel construction with spur gear winch with a stainless steel wire rope.

2. Winch shall be a hand operated type with a brake for load control.

3. Davit crane shall have a telescoping boom that can also be adjusted to achieve an operating radius range of 36 inches to 66 inches. Height adjustment shall be by means of a screw jack. Boom shall telescope to 4 pre-set lengths.

4. Bases shall be constructed from stainless steel and shall be a pedestal mount style as appropriate to their location as shown on the drawings

D. Capacity and Dimensions:

Capacity, lbs	700 lbs at a 48-inch hook radius (Mast Position “B-3”)
Max Lift, Max Lift feet	6
Wire Rope size, length	1/4 inch Stainless Steel, 10 ft

E. **Manufacturers, or Equal:**

1. Thern Commander 1000 5PT10S-M3

PART 3 -- EXECUTION

3.1 GENERAL REQUIREMENTS

1. Davit cranes and bases shall be installed in strict accordance with the manufacturer's published or written instructions.

3.2 FIELD TESTING

A. After completion of the WORK, the CONTRACTOR shall test crane equipment in the presence of the manufacturer's field representative, who shall certify in writing that the equipment meets applicable standards and specifications.

END OF SECTION

SECTION 46 01 00 - EQUIPMENT GENERAL PROVISIONS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide equipment and appurtenant WORK, complete and operable, in accordance with the Contract Documents.

B. The provisions of this Section shall apply to equipment throughout the Contract except where otherwise indicated.

C. Equipment Arrangement: Unless specifically indicated otherwise, the arrangement of equipment indicated is based upon information available from manufacturers at the time of design and is not intended to show exact dimensions particular to a specific manufacturer. Some aspects of the Drawings are diagrammatic and some features of the illustrated equipment arrangement may require revision by the CONTRACTOR to meet the actual equipment requirements proposed by the CONTRACTOR. Structural supports, foundations, piping and valve connections, and electrical and instrumentation connections indicated may have to be altered by the CONTRACTOR to accommodate the equipment provided. No additional payment will be made to the CONTRACTOR for such revisions and alterations. Substantiating calculations and drawings shall be submitted prior to beginning the fabrication of equipment.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Equipment shall be in accordance with the following standards, as applicable and as indicated in each equipment specification:

1. American Society for Testing and Materials (ASTM).
2. American National Standards Institute (ANSI).
3. American Society of Mechanical Engineers (ASME).
4. American Water Works Association (AWWA).
5. American Welding Society (AWS).
6. National Electrical Manufacturers Association (NEMA).
7. Manufacturer's published recommendations and specifications.
8. Occupational Safety and Health Administration (OSHA).
9. Hydraulic Institute (HI)

B. The following standards are referenced in this Section:

ASME B16.1 Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800

ASME B16.5	Pipe Flanges and Flanged Fittings, Steel, Nickel Alloy and other Special Alloys
ASME B46.1	Surface Texture
ANSI S12.6	Method for the Measurement of the Real-Ear Attenuation of Hearing Protectors
ASME B1.20.1	General Purpose Pipe Threads (Inch)
ASME B31.1	Power Piping
ASME B31.3	Process Piping
AWWA C206	Field Welding of Steel Water Pipe
AWWA C207	Steel Pipe Flanges for Waterworks Service - Sizes 4 In. Through 144 In. (100 mm through 3,600 mm)
AWWA D100	Welded Steel Tanks for Water Storage
ASTM A 48	Gray Iron Castings
ASTM A 108	Steel Bars, Carbon, Cold-Finished, Standard Quality

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals.

B. **Shop Drawings**: Furnish complete drawings and technical information for equipment, piping, valves, and controls. Where indicated or required by the ENGINEER, Shop Drawings shall include clear, concise calculations showing equipment anchorage forces and the capacities of the anchorage elements proposed by the CONTRACTOR.

C. **Spare Parts List**: The CONTRACTOR shall obtain from the manufacturer and submit as part of Shop Drawings a list of included and suggested spare parts for each piece of equipment. CONTRACTOR shall also furnish the name, address, and telephone number of the nearest distributor for each piece of equipment.

1.4 QUALITY ASSURANCE

A. Costs: Responsibility shall be the CONTRACTOR'S for performing and paying the costs of inspection, startup, testing, adjustment, and instruction services performed by factory representatives. The OWNER will pay for costs of power and water. If available, the OWNER'S operating personnel will provide assistance in the field testing.

B. Inspection: The CONTRACTOR shall inform the local authorities, such as building and plumbing inspectors, fire marshal, OSHA inspectors, and others, to witness required tests for piping, plumbing, fire protection systems, pressure vessels, safety systems, cranes, and related items to obtain required permits and certificates, and shall pay inspection fees.

C. Quality and Tolerances: Tolerances and clearances shall be as shown on the Shop Drawings and shall be closely adhered to.

1. Machine WORK shall be of high-grade workmanship and finish, with due consideration to the special nature or function of the parts. Members without machined or milled ends and which are to be framed to other steel parts of the structure may have a variation in the detailed length of not greater than 1/16-inch for members 30-feet or less in length, and not greater than 1/8-inch for members over 30-feet in length.

2. Castings shall be homogeneous and free from non-metallic inclusions and defects. Surfaces of castings which are not machined shall be cleaned to remove foundry irregularities. Casting defects not exceeding 12.5 percent of the total thickness and where defects will not affect the strength and serviceability of the casting may be repaired by approved welding procedures. The ENGINEER shall be notified of larger defects. No repair welding of such defects shall be carried out without the ENGINEER'S written approval. If the removal of metal for repair reduces the stress resisting cross-section of the casting by more than 25 percent or to such an extent that the computed stress in the remaining metal exceeds the allowable stress by more than 25 percent, then the casting may be rejected. Costs of casting new material shall be the CONTRACTOR'S responsibility as part of the WORK.

3. Materials shall meet the physical and mechanical properties in accordance with the reference standards.

D. Machine Finish: The type of finish shall be the most suitable for the application as recommended by the equipment manufacturer in micro-inches in accordance with ANSI B46.1. In the absence of manufacturer's recommendations, the following surface finishes shall be used:

1. Surface roughness not greater than 63 micro-inches shall be required for surfaces in sliding contact.

2. Surface roughness not greater than 250 micro-inches shall be required for surfaces in contact where a tight joint is not required.

3. Rough finish not greater than 500 micro-inches shall be required for other machined surfaces.

4. Contact surfaces of shafts and stems which pass through stuffing boxes and contact surfaces of bearings shall be finished to not greater than 32 micro-inches.

E. Manufacturer's Experience: Equipment manufacturer shall have a record of proven experience of at least 5 years of successful, trouble-free operation in similar applications and size equal or larger than the equipment in this Contract. Where indicated in each individual equipment specifications, the CONTRACTOR shall submit this experience record to the ENGINEER for approval.

PART 2 -- PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Noise Level: When the equipment is in operation, no single piece of equipment shall exceed the OSHA noise level requirement of 105 dBA for one hour exposure per day.

B. For service factors of electric motors, see Section 26 05 10 - Electric Motors.

C. Where load classifications are not indicated, the equipment manufacturer's recommendations for service factors shall be utilized.

D. Welding: Unless otherwise indicated, welding shall conform to the following:

1. Latest revision of AWWA D100.

2. Latest revision of AWWA C206.

3. Composite fabricated steel assemblies that are to be erected or installed inside a hydraulic structure, including any fixed or movable structural components of mechanical equipment, shall have continuous seal welds to prevent corrosion of hard-to-coat metallic surfaces.

4. Welding shall be by the metal-arc method or gas-shielded arc method as described in the American Welding Society's "Welding Handbook" as supplemented by other pertinent standards of the AWS. Qualification of welders shall be in accordance with the AWS Standards.

5. In assembly and during welding, the component parts shall be adequately clamped, supported, and restrained to minimize distortion and for control of dimensions. Weld reinforcement shall be as specified by the AWS code. Upon completion of welding, weld splatter, flux, slag, and burrs left by attachments shall be removed. Welds shall be repaired to produce a workmanlike appearance with uniform weld contours and dimensions. Sharp corners of material that are to be painted or coated shall be ground to a minimum of 1/32-inch on the flat.

E. Protective Coating: Equipment shall be painted or coated in accordance with Section 09 96 00 - Protective Coating, unless otherwise indicated. Non-ferrous metal and corrosion-resisting steel surfaces shall be coated with grease or lubricating oil. Coated surfaces shall be protected from abrasion or other damage during handling, testing, storing, assembly, and shipping.

F. Protection of Equipment: Machined and coated surfaces shall be protected by rust inhibitor material prior to shipment. Equipment shall be boxed, crated, or otherwise protected from damage and moisture during shipment, handling, and storage. Equipment shall be protected from exposure to corrosive fumes and shall be kept thoroughly dry. Equipment with anti-friction bearings or sleeve bearings shall be protected from being damaged due to jarring motion during shipment. Pumps, motors, drives, electrical equipment, and other equipment having anti-friction or sleeve bearings shall be stored in weathertight storage facilities prior to installation. For extended storage periods, plastic equipment wrappers should be avoided to prevent accumulation of condensate in gears and bearings. In addition, motor space heaters shall be energized and shafts shall be rotated per manufacturer's recommendation. Equipment delivered to the Site with rust or corroded

parts shall be rejected. If equipment develops defects during storage, it shall be disassembled, cleaned, recoated, or otherwise corrected to restore it to original condition.

G. Identification of Equipment Items

1. At the time of shipping, each item of equipment shall have a legible identifying mark corresponding to the equipment number in the Contract Documents for the particular item.

2. After installation, each item of equipment shall be given permanent identification.

a. Pumps, compressors, and blowers of 150 horsepower or less shall receive acrylic plastic nametags.

b. Pumps, compressors, and blowers larger than 150 horsepower shall receive stainless steel plate nametags.

H. Vibration Isolators: Air compressors, blowers, engines, inline fans shall be provided with restrained spring-type vibration isolators or pads per manufacturer's written recommendations. Vibration isolations shall be provided with seismic restraint.

I. Equipment Maximum Allowable Vibration Level: Unless otherwise indicated, maximum allowable vibration level shall be in accordance with the acceptance criteria recommended by the reference Standard for that particular type of equipment

J. Shop Fabrication: Shop fabrication shall be performed in accordance with the Contract Documents and the Shop Drawings.

K. Controls: Equipment and system controls shall be in accordance with Division 40 - Instrumentation.

2.2 EQUIPMENT SUPPORTS AND FOUNDATIONS

A. Equipment Supports: Equipment components and supports, anchors, and seismic restrainers shall be adequately designed for static, dynamic, wind, and seismic loads. See design criteria indicated on General Structural sheets.

1. Anchors: Anchor bolts shall be in accordance with Section 05 05 19 Post-Installed Anchors in Concrete and Section 05 50 00 - Miscellaneous Metalwork. CONTRACTOR shall determine the size, type, capacity, location, and other placement requirements of anchorage elements. Anchoring methods and leveling criteria in the manufacturer's literature shall be followed. Submit methods and criteria with the Shop Drawings.

2. Equipment Foundations: Unless otherwise indicated, mechanical equipment, tanks, control cabinets, enclosures, and related equipment shall be mounted on minimum 3.5-inch high concrete bases. Unless otherwise indicated on the Drawings, pumps, blowers, compressors and engine driven equipment shall be provided with a concrete foundation with a total weight equal to at least five times the weight of the equipment. Concrete foundations shall be isolated from the building floor in order to prevent transfer of vibration from the equipment to the building structure. The CONTRACTOR through the equipment manufacturer shall verify the size and weight of equipment foundation to insure compatibility with equipment.

3. Equipment Grout: Mechanical equipment installed on top of concrete foundations or bases shall be provided with non-shrink concrete or epoxy grout as indicated and as specified in Section 03 60 00 - Grouting. Grout shall be applied between the base plate and the concrete foundation or base in accordance with the grout manufacturer's recommendation. Grout shall be free of void space.

2.3 GEARS AND GEAR DRIVES

A. Unless otherwise indicated, gears shall be of the spur, helical, or spiral-bevel type, designed and manufactured in accordance with AGMA Standards, with a service factor suitable for load class, mechanical service and thermal rating adjustment, a minimum L-10 bearing life of 60,000 hours, and a minimum efficiency of 94 percent. Peak torque, starting torque, and shaft overhung load shall be checked when selecting the gear reducer. Worm gears shall not be used unless specifically approved by the ENGINEER.

B. Gear speed reducers or increasers shall be of the enclosed type, oil- or grease-lubricated and fully sealed, with a breather to allow air to escape but keep dust and dirt out. The casing shall be of cast iron, ductile iron, or heavy-duty steel construction with lifting lugs and an inspection cover for each gear train. An oil level sight glass and an oil flow indicator shall be provided, located for easy reading.

C. Gears and gear drives that are part of an equipment assembly shall be shipped fully assembled for field installation.

D. Material selections shall be selected by the manufacturer, provided the above AGMA values are met. Input and output shafts shall be adequately designed for the service and load requirements. Gears shall be computer-matched for minimum tolerance variation. The output shaft shall have 2 positive seals to prevent oil leakage.

E. Oil level and drain locations shall be easily accessible. Oil coolers or heat exchangers with required appurtenances shall be provided when necessary.

F. Where gear drive input or output shafts from one manufacturer connect to couplings or sprockets from a different manufacturer, the CONTRACTOR shall have the gear drive manufacturer furnish a matching key taped to the shaft for shipment.

2.4 DRIVE CHAINS

A. Power drive chains shall be commercial type roller chains meeting ASME Standards.

B. A chain take-up or tightener shall be provided in every chain drive arrangement to provide easy adjustment.

C. A minimum of one connecting or coupler link shall be provided in each length of roller chain.

D. Chain and attachments shall be of the manufacturer's best standard material and be suitable for the process fluid.

2.5 SPROCKETS

A. General: Sprockets shall be used in conjunction with chain drives and chain-type material handling equipment.

B. Materials: Unless otherwise indicated, materials shall be as follows:

1. Sprockets with 25 teeth or less, normally used as a driver, shall be made of medium carbon steel in the 0.40 to 0.45 percent carbon range.

2. Type A and B sprockets with 26 teeth or more, normally used as driven sprockets, shall be made of minimum 0.20 percent carbon steel.

3. Large diameter sprockets with Type C hub shall be made of cast iron conforming to ASTM A 48, Class 30.

C. Sprockets shall be accurately machined to ASME Standards. Sprockets shall have deep hardness penetration in tooth sections.

D. Finish bored sprockets shall be furnished complete with keyseat and set screws.

E. To facilitate installation and disassembly, sprockets shall be of the split type or shall be furnished with Taper-Lock bushings as required.

F. Idler sprockets shall be provided with brass or Babbitt bushings, complete with oil hole and axial or circumferential grooving with stainless steel tubing and grease fitting extended to an accessible location. Steel collars with set screws may be provided in both sides of the hub.

2.6 BEARINGS

A. General: Bearings shall conform to the standards of the American Bearing Manufacturers Association, Inc. (ABMA).

B. To assure satisfactory bearing application, fitting practice, mounting, lubrication, sealing, static rating, housing strength, and lubrication shall be considered in bearing selection.

C. Re-lubricatable type bearings shall be equipped with hydraulic grease fitting in an accessible location and shall have sufficient grease capacity in the bearing chamber.

D. Lubricated-for-life bearings shall be factory-lubricated with the manufacturer's recommended grease to insure maximum bearing life and best performance.

E. Anti-Friction Type Bearing Life: Except where otherwise indicated, bearings shall have a minimum L-10 life expectancy of 5 years or 20,000 hours, whichever occurs first. Where so indicated, bearings shall have a minimum rated L-10 life expectancy corresponding to the type of service, as follows:

Type of Service	**Design Life, years**	**L-10 Design Life, hours**
	(whichever comes first)	
8-hour shift	10	20,000
16-hour shift	10	40,000
Continuous	10	60,000

F. Bearing housings shall be of cast iron or steel and bearing mounting arrangement shall be as indicated or as recommended in the published standards of the manufacturer. Split-type housings may be used to facilitate installation, inspection, and disassembly.

G. Sleeve Type Bearings: Sleeve-type bearings shall have a cast iron or ductile iron housing and Babbitt or bronze liner. Bearing housing shall be bolted and doweled to the lower casing half. These housings shall be provided with cast iron caps bolted in place and the bearing end caps shall be bored to receive the bearing shells. Sleeve bearings shall be designed on the basis of the maximum allowable load permitted by the bearing manufacturer. If the sleeve bearing is connected to an equipment shaft with a coupling, the coupling transmitted thrust will be assumed to be the maximum motor or equipment thrust. Lubricant, lubrication system, and cooling system shall be as recommended by the bearing manufacturer. In accordance with the Lead Reduction Act, sleeve bearings containing lead material exposed to drinking water shall not be acceptable.

H. Plate Thrust Bearings: Thrust bearings shall be the Kingsbury Type, designed and manufactured to maintain the shaft in the fixed axial position without undue heating or the necessity of adjustment or attention. Bearings shall be oil lubricated to suit the manufacturer's standard method of lubrication for the specific bearing. If bearing cooling is required, manufacturer shall provide heat exchangers, incluging necessary intrumentation and controls, piping, filters, and valves.

2.7 PIPING CONNECTIONS

A. Pipe Hangers, Supports, and Guides: Pipe connections to equipment shall be supported, anchored, and guided to avoid stresses and loads on equipment flanges and equipment. Supports and hangers shall be in accordance with Section 40 05 07 - Pipe Supports.

B. Flanges and Pipe Threads: Flanges on equipment and appurtenances shall conform to ASME B16.1, Class 125, or B16.5, Class 150, unless otherwise indicated. Pipe threads shall be in accordance with ASME B1.20.1 and Section 40 05 00 - Piping, General.

C. Insulating Connections: Insulating bushings, unions, couplings, or flanges, as appropriate, shall be used in accordance with the requirements of the specifications.

2.8 GASKETS AND PACKINGS

A. Gaskets and packings shall be in accordance with the requirements of the specifications. Gaskets and packings in contact with drinking water shall be NSF 61 approved. Elastomeric materials in contact with water with chloramines, or water with ozone residual shall be made of Teflon or Viton-A, or equal.

B. Packing around valve stems and reciprocating shafts shall be of compressible material, compatible with the fluid being used. Chevron-type "V" packing shall be Garlock No. 432, John Crane Everseal, or equal.

C. Packing around rotating shafts (other than valve stems) shall be "O" rings, stuffing boxes, or mechanical seals, as recommended by the manufacturer and approved by the ENGINEER, in accordance with Section 43 20 00 - Pumps, General.

2.9 NAMEPLATES

A. Equipment nameplates of stainless steel shall be engraved or stamped and fastened to the equipment in an accessible location with No. 4 or larger oval head stainless steel screws or drive pins. Nameplates shall contain the manufacturer's name, model, serial number, size, characteristics, and appropriate data describing the machine performance ratings.

2.10 TOOLS AND SPARE PARTS

A. Tools: The CONTRACTOR shall furnish one complete set of special wrenches and other special tools necessary for the assembly, adjustment, and dismantling of the equipment. Tools shall be of best quality hardened steel forgings with bright finish. Wrench heads shall have work faces dressed to fit nuts. Tools shall be suitable for professional work and manufactured by Snap On, Crescent, Stanley, or equal. The set of tools shall be neatly mounted in a labeled toolbox of suitable design provided with a hinged cover.

B. Spare parts shall be furnished as indicated in the individual equipment sections. Spare parts shall be suitably packaged in a metal box and labeled with equipment numbers by means of stainless steel or solid plastic nametags attached to the box.

2.11 EQUIPMENT LUBRICANTS

A. The CONTRACTOR shall provide lubricants for equipment during shipping, storage, and prior to testing, in accordance with the manufacturer’s recommendations. Lubricants that could come in contact with potable water shall be food grade lubricants. After successful initial testing, final testing, and satisfactory completion startup testing per Section 01 75 00 - Equipment Testing and Plant Startup, the CONTRACTOR shall conduct one complete lubricant change on equipment. In addition, the CONTRACTOR shall be responsible for the proper disposal of used lubricants. The OWNER will then be responsible for subsequent lubricant changes

PART 3 -- EXECUTION

3.1 SERVICES OF MANUFACTURER

A. Installation, Supervision, Inspection, Startup, and Field Adjustment: An authorized, experienced, and competent service representative of the manufacturer shall visit the Site to perform the following:

1. Supervision of the installation of the equipment

2. Inspection, checking, and adjusting the equipment and approving its installation

3. Startup and field testing for proper operation, efficiency, and capacity

4. Performing field adjustments during the test period to ensure that the equipment installation and operation comply with requirements

5. Certify in writing that the equipment and controls have been properly installed, aligned, lubricated, adjusted, and readied for operation.

6. Unless otherwise indicated, factory representative shall be present at the job site for half a day.

B. Owner Staff Training

1. Owner staff training shall be in accordance with Section 01 79 00 – Owner Staff Training.

2. Unless otherwise indicated, a minimum of one 4-hour training session shall be provided for each type of equipment.

3.2 INSTALLATION

A. General: Equipment shall be installed in accordance with the manufacturer's written recommendations.

B. Alignment: Equipment shall be field tested to verify proper alignment.

3.3 PACKAGED EQUIPMENT

A. When any system is furnished as pre-packaged equipment, the CONTRACTOR shall coordinate space and structural requirements, clearances, utility connections, signals, and outputs with Subcontractors to avoid later change orders.

B. If the packaged system has any additional features (as safety interlocks, etc.) other than required by the Contract Documents, the CONTRACTOR shall coordinate such features with the ENGINEER and provide material and labor necessary for a complete installation as required by the manufacturer.

3.4 FIELD ASSEMBLY

A. Studs, cap screws, bolt and nuts used in field assembly shall be coated with Never Seize compound or equal.

3.5 WELDING

A. Welds shall be cleaned of weld-slag, splatter, etc. to provide a smooth surface.

3.6 FIELD TESTS

A. Where indicated by the individual equipment sections, equipment shall be field tested after installation to demonstrate satisfactory operation without excessive noise, vibration, or overheating of bearings or motor.

B. The following field testing shall be conducted:

1. Start equipment, check, and operate the equipment over its entire operating range. Vibration level shall be within the amplitude limits as indicated or as recommended by the reference applicable standards.

2. Obtain concurrent readings of motor voltage, amperage, capacity, vibration, and bearing temperatures.

C. The ENGINEER shall witness field-testing. The CONTRACTOR shall notify the ENGINEER of the test schedule 3 Days in advance.

D. In the event that any equipment fails to meet the test requirements, the equipment shall be modified and retested until it satisfies the requirement.

END OF SECTION

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SECTION 46 21 34 – PRESSURIZED SCREEN FILTERS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide self-cleaning screen filters, and all appurtenant work, complete and operable, in accordance with the Contract Documents. The screen filters shall be provided mounted to a skid complete with supply and discharge piping connections, isolation and bypass valves, automated backwash valves, backwash discharge manifold, and a common control panel. All WORK shall be performed in accordance with the applicable codes and regulations.

B. The Screen Filters shall be low-pressure type.

C. The requirements of Section 46 01 00 – Equipment General Provisions, apply to the WORK of this Section.

1.2 SUPPLIER QUALIFICATIONS

A. The screen filter manufacturer / distributor shall have a minimum of 5 years' experience in design manufacturing and installation of screen filters. Upon request, the screen filter manufacturer shall supply no less than 10 aquaculture references including company name and contact information.

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals.

B. Shop Drawings

1. Manufacturer's literature and drawings demonstrating compliance with this Section.

2. Dimensional drawings showing, at minimum, the following:

a. Equipment dimensions including minimum recommended clearances;

b. Materials of construction;

c. Arrangement of equipment internals;

d. Leveling and anchoring requirements;

e. Control panel size and layout;

f. Wiring schematic.

C. Product information or catalog cuts for buyout components.

D. Technical Manual

E. Certificate or letter of confirmation of equipment warranty

1.4 WARRANTY

A. The MANUFACTURER shall warrant all equipment for a period of 12 months from date of successful pre-commissioning.

B. During the warranty period, the MANUFACTURER shall replace or repair non-consumable parts proved to be defective in material or workmanship upon written notice, provided that the equipment is installed in accordance with the manufacturer's instructions and operated and maintained in accordance with the instructions contained in the MANUFACTURER's Technical Manual.

C. The MANUFACTURER shall be liable for the direct labor and material costs of repairs or replacement performed by the OWNER during the warranty period, but only if the MANUFACTURER gives prior authorization in writing for the repair or replacement involved.

PART 2 -- PRODUCTS

2.1 GENERAL

A. The screen filters shall be provided pre-installed in a vertical stack configuration on a common skid. The skid shall include flanged connections for supply and discharge piping, isolation valves for each filter unit, a bypass valve, supports for the screen filters, flush valves and actuators, a common manifold for backwash discharge with flanged connections, integrated control panel, and control instrumentation.

B. Equipment Requirements

Equipment No	SF-1
Location	Water Treatment Shed
Atmosphere	Indoors
Flow Rate	2,250 GPM
System Operating Pressure, Supply Side (psi)	20
Fine Filter Opening Size	40 micron
Maximum Skid Footprint Dimensions	110" x 52"
Supply, Discharge, and Bypass Pipe Size	10 inches
Backwash Discharge Manifold Pipe Size	4 inches
Electrical Supply	120/240 VAC, 1-Phase, 60 Hz

2.2 DESIGN AND CONSTRUCTION

A. Coarse Screen Pre-Filter

1. The coarse screen pre-filter shall be constructed of stainless steel 316L with perforations to protect the fine screen from damage.

B. Fine Filter Element

1. The fine screen filter shall be constructed of stainless steel 316L or better.

2. Provide supports for the filter

C. Pressure Differential Gauge

1. The differential pressure switch shall be preset at 7-psi and enclosed in a NEMA 4X enclosure. The differential pressure switch shall have an easy to read “pointer & dial” gauge.

D. Flush Valves

1. The flush valve shall be stainless steel with an electric actuator. Flange holes shall meet Class 150 flange locations. Valve shall be rated for up to 175 PSI service. The actuator enclosure shall be NEMA 4X rated. Valve position will be indicated on a valve status display.

E. Suction Scanner

1. The suction scanner lateral movement shall be regulated with a linear actuator.

F. Electronic Backwash Controller

1. Electronic backwash controller shall monitor and activate cleaning cycles.

2. Controller shall be capable of operating a single filter or up to four filters in parallel.

3. Controller shall be capable of activating a backwash cycle by each of the following: periodic timer, differential pressure, and manual activation.

4. Controller shall include a display monitor to indicate controller status and display the backwash count and timers.

G. Isolation Valves

1. Provide butterfly isolation valves with manual lever arm actuators integrated with the skid. See requirements of Section 43 30 14 - Butterfly Valves.

H. Skid

1. Provide a structural skid frame designed to support all components of the supply package. Anticipated plan dimensions are approximately 64” x 36”.

2. All skid components shall be stainless steel 304 or better unless otherwise specified.

3. Skid shall include lifting eyes, or equivalent, to allow the skid to be lifted as a single unit.

4. Provide anchoring locations in each corner of the skid. Supplier shall provide guidance for anchor type and minimum anchor embedment into the concrete.

2.3 TOOLS AND SPARE PARTS

A. As applicable, special tools shall be furnished in accordance with Section 46 01 00 - Equipment General Provisions.

2.4 MANUFACTURERS OR APPROVED EQUAL

A. **Forsta Filters**

B. **Amiad**

C. **Tekleen**

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Installation shall be per the manufacturer's printed recommendations and as indicated.

3.2 START-UP SUPERVISION

A. The services of a qualified representative of the manufacturer shall be furnished by the CONTRACTOR for minimum of 1 day to check the installation, start-up the equipment and instruct personnel in proper operation and maintenance.

3.3 OWNER STAFF TRAINING

A. Provide owner staff training for the screen filters in accordance with the requirements of Section 46 01 00 - Equipment General Provisions.

END OF SECTION

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SECTION 46 21 80 – CONTAINERIZED OXYGEN GENERATION

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide one complete vacuum swing adsorption (VSA) system installed within a 10-ft shipping container. The container shall be provided complete with electrical panels, HVAC, space heater, and other components necessary for successful performance and to minimize installation effort and field connections. The equipment shall be fabricated, factory tested, and shipped as a fully assembled unit.

B. The equipment for oxygen production shall be as specified herein and shown on the Drawings and includes, but is not necessarily limited to, the following:

1. All instrumentation and controls required for a complete and operable system in accordance with specifications shall be provided. All skid- and panel-mounted conduit and wires, including instrumentation and control system, status wiring and instrumentation power wiring for each plant.
2. All vessel support structures, valves, skid-mounted piping and fittings, skid-mounted piping support structures, and accessories necessary for the VSA systems.
3. Mandated spare parts as specified herein.

C. Interconnecting piping between the container and exterior equipment shall be provided by the Contractor.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Publications are referred to in the text by basic designation only. Where a date is given for reference standards, that edition shall be used. Where no date is given for reference standards, the latest edition available on the date of Notice Inviting Bids shall be used.

Anti-Friction Bearing Manufacturers Association (AFBMA)	
ANSI B16.5	Pipe Flanges and Flanged Fittings.
ANSI/ASME PTC 9	Performance Test Code - Displacement Compressors, Vacuum Pumps and Blowers.
ANSI/ASME PTC 10	Performance Test Code - Compressors and Exhausters.
ASME Section VIII, Division 1	Rules for Construction of Pressure Vessels
ASTM A 105	Standard Specification for Forgings, Carbon Steel, for Piping Components.
ASTM A 167	Standard Specification for Stainless and Heat-resisting Chromium-Nickel Steel Plate, Sheet, and Strip.

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ASTM A 216 — Standard Specification for Steel Casings, Carbon Suitable for Fusion Welding, for High Temperature Services.

Occupational Safety and Health Administration (OSHA)

National Electrical Manufacturers Association (NEMA)

1.3 CONTRACTOR SUBMITTALS

A. The Contractor shall submit complete shop drawings in compliance with Section 01 33 00 – Contractor Submittals.

B. The CONTRACTOR shall submit data for the VSA systems as follows:

1. VSA system layout drawings including all components and interconnecting piping.

2. Manufacturer and model number for the VSA system including size, weight, type, materials, discharge air flow, pressure, temperature, power requirements, motor speed, maximum sound pressure levels, and cooling air requirements.

3. Operation and Maintenance Data: Operation and maintenance instructions shall be furnished in compliance with Section 01 33 00 – Contractor Submittals. The instructions shall also describe safety procedures and precautions.

4. Storage requirements for equipment, identifying space needs, handling requirements and special conditions.

1.4 UTILITIES

A. Electric power will be provided to each VSA system at 460 volt, 3 phase, 60 Hz. Control power to control panels, if separate, will be provided at 120 volt, 1 phase, 60 Hz.

1.5 OXYGEN SERVICE

A. All equipment, valves, analyzers, seals, gaskets, valve seats, and associated appurtenances to be used in oxygen service shall be furnished, cleaned, sealed, and protected as appropriate for oxygen service.

1.6 WARRANTY

A. The SUPPLIER shall warrant all equipment for a period of one year from the Interim Acceptance or 2 years from startup whichever is later.

B. During the warranty period, the Manufacturer shall replace or repair non-consumable parts proved to be defective in material or workmanship upon written notice, provided that the equipment is installed in accordance with the manufacturer's instructions and operated and maintained in accordance with the instructions contained in the manufacturer's Technical Manual.

1.7 ELECTRICAL REQUIREMENTS

A. Verify the incoming electrical requirements for the Oxygen Generators with Division 26 and Division 40.

B. Refer to the electrical, instrumentation and controls drawings for information.

C. Exact electrical cable sizing to the Oxygen Generator system(s) shall be verified prior to ordering or installing any electrical feeder cables.

D. Grounding of the Oxygen Generator system(s) shall be in accordance with the suppliers' recommendations and the Canadian Electrical Code (CEC). Install all sensing rods as required by the supplier.

E. Oxygen Generator control panel(s) shall have their own integral HMI (Human Machine Interface) for local control and status indication of system.

F. All control power for the system shall be derived from the incoming power feed from Division 26. All control transformers and power supplies shall be integral to the Oxygen Generator control panel(s) and shall be provided by the supplier.

G. The following status signals shall be provided from the Oxygen Generator system(s) to the local PLC control system and shall include but not limited to:

1. Oxygen Generator System Fault – Alarm output to PLC – Dry contacts on the Oxygen Generator system
2. On/Off Status – Status indication to the PLC – Dry contacts on the Oxygen Generator system
3. Low Purity Status – Status Indication to the PLC - Dry contacts on the Oxygen Generator system.
4. System Setpoint - 4-20ma Indication to the PLC - Dry contacts on the Oxygen Generator system.

PART 2 -- PRODUCTS

2.1 GENERAL

A. The VSA system shall deliver high purity oxygen gas production at the oxygen purity, dewpoint, and pressure specified herein, and at the altitude and environmental conditions specified in Section 46 00 00 – Equipment General Provisions.

B. The product gas from each VSA system shall continuously meet the specified quality requirements at a minimum pressure of 55 psig as measured at the outlet from the oxygen booster compressor under all operating conditions.

C. An integrated control system shall automatically adjust product supply in response to pressure measured in the pipeline and internally adjust itself to achieve power reductions as a result of supply turndown. As pressure changes in this pipeline, the VSA system shall increase or decrease product flow as needed to maintain the downstream pressure. Product flow shall be limited to ensure that the VSA system operates within an effective

range, and the lag VSA system will be automatically initiated or switch made to LOX supply as appropriate. When all available VSA systems are operating and downstream pressure drops, regulating valves shall provide vaporized oxygen flow from the LOX storage tanks to maintain pressure in the ozone generator supply pipeline. Design shall be such that operator intervention will only be required during startups, or shutdowns, maintenance, and process optimization.

D. All equipment components shall be designed for the space allocated in standard 10 foot shipping container.

2.2 DESIGN CRITERIA

Discharge Flow Rate	135 kg/d
Oxygen Purity at Discharge Rate	93%
Oxygen Output Pressure, Minimum	55 psig
Power Requirements	480V/3ph

2.3 VSA EQUIPMENT CONTROL PANEL

A. Each VSA equipment train shall be provided with a VSA equipment control panel. The VSA equipment control panels shall include all controls and protective devices and functions as recommended by the supplier for a complete and operational system.

2.4 AIR BLOWERS

A. The air blowers shall be of industrial quality. Each air blower system shall be provided with an inlet air filter, inlet silencer, blower and electric motor drive mounted on a common structural steel baseplate skid, discharge air temperature adjustment (if required), discharge separator (if air discharge aftercooler is required), vent discharge silencer, valving and all miscellaneous equipment required for operation.

B. Air Filter: The inlet air filter shall be of a dry element type. The air filter particulate size shall remove a minimum 99 percent of all 10 micron and larger particles.

C. Inlet and Vent Discharge Silencers:

1. Inlet Silencers: The arrangement of the inlet air silencer and inlet air filter shall be designed by the suppliers to limit sound pressure levels to 85 dBA at 3 feet in any direction from the point of air discharge from the pipe to the atmosphere under all operating conditions.

2. Vent Discharge Silencers: Air blower discharge vent silencers shall be provided to limit sound pressure levels to 85 dBA at 3 feet in any direction from the point of air discharge from the pipe to the atmosphere under all operating conditions.

D. The supplier shall supply an instrumentation and control system capable of operating the blower unit. All required instrumentation to control the blower functions including capacity,

antisurge control, startup, and shutdown of the blower train shall be connected to the VSA equipment train control panel which will connect with the MCP.

2.5 VSA ADSORBENT VESSEL SYSTEM

A. VSA vessel system shall consist of adsorbent vessels, vessel switching valves, vessel interconnecting piping, vessel supporting structure, pipe supports, instrumentation, and controls which are delivered as a preassembled, skid-mounted package.

B. If valves, interconnecting piping, and vessels are not provided as a single preassembled skid-mounted package, the CONTRACTOR shall provide all interconnecting piping between skid-mounted equipment. Pipe and vessel supports shall be provided by the oxygen system supplier.

C. Adsorbent Vessels: Adsorbent containing vessels shall be supplied for the VSA system. Each vessel shall be supplied with sufficient adsorptive materials to generate the required oxygen production, purity, and dewpoint.

D. Each of the VSA vessels shall have a design rating to satisfy the required train production and turndown as specified herein and which will satisfy the following conditions:

1. Oxygen Purity: Minimum of 90 percent purity, continuous production.

2. Outlet Oxygen Dewpoint: Minus 80 degrees F (at line pressure, continuous).

3. Outlet Hydrocarbon Content: Less than 10 ppm maximum.

4. Outlet Carbon Dioxide Content: Less than 5 ppm maximum.

E. Oxygen buffer storage tanks: Sound pressure levels from tanks and piping installed indoors shall be limited to a maximum 85 dBA at 3 feet in any direction under all operating conditions. The suppliers shall provide in-line silencers, tank and pipe acoustical insulation, or other provisions, if required, to limit sound pressure production to the specified level.

F. Each VSA vessel system shall contain automatic process valves and instrumentation for control and monitoring of the oxygen separation process, and instrumentation for automated sensing, monitoring, and shutdown of the process as required.

G. Protective devices recommended by the manufacturer to alarm and/or shutdown the VSA unit shall be furnished as a part of the system.

2.6 INSTRUMENT AIR PACKAGE

A. The VSA system shall have a standalone, packaged instrument air system sized to operate the pneumatic valves of the VSA adsorbers and any other appurtenances of furnished equipment which require instrument air supply.

2.7 VACUUM PUMPS

A. The VSA system shall include a skid-mounted rotary lobe waste gas vacuum pump. The vacuum pump shall be single or multiple stage configuration. Each vacuum pump system shall be provided with a discharge gas silencer/separator, electric motor drive, lube oil system and all miscellaneous equipment required for operation.

2.8 COMPRESSORS

A. Compressors supplied with the units shall be oiless scroll type compressors of industrial quality and designed and furnished for indoor installation.

2.9 VALVES

A. Automatic Switching Valves: The automatic air, waste gas, and oxygen switching valves and actuators located in the piping directly associated with the adsorption vessels are to be provided by the oxygen system supplier as an integral part of the skid.

2.10 SURFACE PREPARATION, SHOP PAINTING, AND GALVANIZING

A. All surfaces to be painted shall be prepared, shop primed, and powder coated with manufacturer's standard coatings. Color shall be white.

B. Vessel and tank coatings damaged during shipment or installation shall be repaired in the field using identical finish coating material.

2.11 FACTORY TESTS

A. Oxygen system supplier shall perform shop and field tests required for product performance verification and certification.

2.12 MANUFACTURERS

A. The oxygen generation systems shall be provided by the following suppliers, or approved equal:

1. **Oxygen Solutions, Inc**.

PART 3 -- EXECUTION

3.1 START UP AND TESTING

A. After all VSA equipment has been completely installed, initially inspected, and operationally tested as specified herein and in Division 1, specific conditional acceptance tests shall be performed by the supplier in the presence of the COR and/or COTR as follows:

1. Test the VSA system under actual startup and operating conditions including minimum and maximum design oxygen production rates as specified herein, using system mounted instruments following calibration, to determine that the operation is

satisfactory and that the equipment provides the specified oxygen gas production and oxygen gas quality as stated in the specifications and will automatically regenerate the adsorbent beds satisfactorily. Prior to conducting the test, a copy of the proposed test data sheet shall be submitted for approval. The test data shall indicate, as a minimum, the time, inlet air flow rate, inlet air temperature, inlet air humidity, inlet air pressure, outlet oxygen flow rate, outlet oxygen temperature, outlet oxygen pressure, outlet waste gas temperature, outlet gas oxygen percent by volume, outlet oxygen gas dewpoint, regeneration cycle times, and pressure differential at any coalescing and particulate filters for the specified minimum and maximum oxygen production rates. The supplier shall submit to the OWN COR ER and/or COTR for approval a field test report on each unit including a test data sheet.

2. A minimum of 2 hours of complete adsorbing and regeneration cycles shall be conducted for each test setting, during which the readings shall be taken and recorded at 15-minute intervals (minimum).

B. If the equipment performance does not meet the specifications, corrective measures shall be taken or the equipment shall be removed and replaced by the oxygen system supplier with units which will satisfy the condition specified, at no additional expense to the Government.

3.2 MANUFACTURERS' REPRESENTATIVE'S DUTIES

A. A factory or other authorized representative of each manufacturer of the VSA system components shall be at the work site for minimum of 1 day to inspect the final installation, supervise test runs of equipment, and provide training as specified in Division 1.

END OF SECTION

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SECTION 46 34 22 – CIRCULAR CENTER FEED CLARIFIER

PART 1 -- GENERAL

1.1 THE SUMMARY

A. General: The CONTRACTOR shall provide fiberglass reinforced plastic center feed clarifier, and appurtenant WORK, complete and operable, in accordance with the Contract Documents.

B. The WORK under this Section shall be furnished by manufacturers having experience in the manufacture of similar products and having a record of successful installations.

C. Plastic and fiberglass items shall be manufactured of material suitable for potable water or the chemicals they contact, and shall be certified for such use on the Shop Drawings. Tanks shall be designed and checked for loads to be incurred during installation and service.

1.2 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Commercial Standards

1. ASTM A193, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications

2. ASTM A194, Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both

3. ASTM C 581, Practice for Determining Chemical Resistance of Thermosetting Resins Used in Glass Fiber Reinforced Structures, Intended for Liquid Service

4. ASTM D 638, Test Method for Tensile Properties of Plastics

5. ASTM D 695, Test Method for Compressive Properties of Rigid Plastics

6. ASTM D 790, Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

7. ASTM D 883, Definitions of Terms Relating to Plastics

8. ASTM D 2563, Recommended Practice for Classifying Visual Defects in Glass-Reinforced Plastic Laminate Parts

9. ASTM D 2583, Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor

10. ASTM D 2584, Test Method for Ignition Loss of Cured Reinforced Resins

11. ASTM D 3299, Filament-Wound Glass Fiber Reinforced Thermoset Resin Chemical-Resistant Tanks

12. ASTM D 4097, Contact-Molded Glass-Fiber-Reinforced Thermoset Resin Chemical-Resistant Tanks

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B. When 2 or more of the above regulations are applicable, the more stringent requirement shall be met.

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Contractor Submittals.

B. Shop Drawings: Include detailed bill of materials listing components, resins, catalysts, promoters, ultraviolet light absorbers, agents, reinforcing materials, etc., with manufacturer's name, trade and identification marks. The laminate sequence used for tanks must either be attached to or included on drawings used by the fabricator's shop personnel.

1. Dimensions including anchor bolt layouts.

2. Details of structural support members.

3. Equipment capacity, gallons.

4. Maximum design specific gravity.

5. Equipment weight, empty and filled with water.

6. Laminate sequence of construction and materials of construction.

7. Specifications for supplied bolting, gaskets, and accessory items.

PART 2 -- PRODUCTS

2.1 TANK DESIGN

A. Standards: Construction of tanks shall be in accordance with ASTM standards listed herein.

B. Design: Fiberglass tanks shall be constructed using the contact molded method. The design stress shall be 10 percent of the minimum ultimate tensile stress of the selected laminated thickness, thereby providing a factor of safety of 10:1 against shell or head rupture. Tanks shall have a minimum wall thickness of 5/16-inch, openings and accessories where indicated, and 1-1/2 inch radius sidewall knuckles.

C. The following fiberglass tank is included with this Section.

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Description	Center Circular Feed Clarifier
Diameter (ft)	20
Vertical Sidewall Height (ft)	11.75
Nominal Freeboard (ft)	1.75
Side Water Depth (ft)	10.00
Bottom Slope (in/ft)	3
Nominal Volume (gal)	25,457
Max. Influent Flowrate (gpm)	200
Center Feedwell Diameter (ft)	6 (Open top and open bottom)
Center Feedwell Height (ft)	2.5
Overflow Weir Type	V-Notch
Weir Notch Depth (in)	480/3/60

2.2 MATERIALS OF CONSTRUCTION

A. **Resin**: Resin shall be manufacturer's standard polyester resin, or approved equal. To allow verification that fresh resin is used, manufacturer lot numbers of the resin used shall be shipped with the completed tank. Fillers up to 2 percent by weight of thixotropic agent may be used for viscosity control in the paraffinated topcoat on vertical surfaces, provided it will not interfere with visual inspection. The cure system used for the resin shall be in accordance with resin manufacturer's current recommendations. Proper curing of the resin is the CONTRACTOR's responsibility. Products in this specification shall be cured to at least 90 percent of the minimum Barcol hardness set by the resin manufacturer. This requirement applies to both interior and exterior surfaces. No chemical-resistant surface, either interior or exterior, shall be acetone sensitive. Where application of polyester film to prevent air inhibition of these surfaces is impractical, a wax containing resin coating formulated according to the resin manufacturer's most recent recommendations must be used. The minimum thickness of the polyester film shall be 4-mils.

B. **Color**: The inside surface of the tanks shall be pigmented to be **black**. The outside surface of the tanks shall not be pigmented. By weight, 5 percent ultraviolet stabilizer shall be added to exterior surfaces.

C. **Reinforcement**: Chopped strand mat shall be Type E (electrical borosilicate) glass, 1-1/2 oz per sq ft, with silane finish and a styrene-soluble reactive binder. Continuous roving used in chopper gun for spray-up shall be Type E glass. Woven roving shall be Type E glass, nominal 24 oz/sq yd, 4 by 5 weave, with silane finish. Continuous roving used for filament winding shall be Type E glass with a silane finish.

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D. **Insulation**: Insulation shall be two-inch thick polyurethane foam with a minimum density of 2 lb/cu ft. The insulation shall be of uniform density and thickness. The vertical sides of the tanks shall be insulated. The insulation shall be protected by a minimum 1/8-inch thick fiberglass covering of chopped glass strand and filament winding. External expansion joints shall be provided in the insulation covering. They shall be designed to prevent seepage from resin or an overflowing tank. Nozzles and fittings shall have insulation replaced around lay-up areas. False bottoms, where indicated, shall be filled with closed core material such as foamed urethane.

E. **Gelcoat**: A separately cured, 20 mils thick, unreinforced isopthalic gel coat shall be applied to both the inside and outside of the tank. The gelcoat shall be black on the inside. Both interior and exterior gelcoats shall be UV stabilized by the manufacturer.

2.3 CONSTRUCTION

A. **General**: Tanks shall be contact molded on a highly polished monolithic male hold.

B. **Laminate Construction**: Laminate construction shall be as follows:

1. Chemical-Resistant Barrier: Tanks shall consist of an inner surface and an interior layer which constitutes the chemical-resistant barrier, and an exterior or structural layer. The inner surface shall be free from cracks and crazing, with a smooth finish. The resin-rich surface shall be between 0.010- and 0.020-inch thick and be reinforced with C-glass. The resin to glass ratio should be approximately 90 percent resin and 10 percent glass. The interior layer shall consist of either (1) 3 layers of 1-1/2 oz/sq ft E-glass chopped strand mat, or (2) 2 layers of 1-1/2 oz/sq ft E-glass chopped strand mat followed by one pass by the spray-up process. In no case shall the combined thickness of the inner surface and the interior layer be less than 0.100-inch. The glass content for the interior layer shall be 20 to 30 percent.

2. Contact Molded Laminates: The contact molded process includes fabrication by the hand lay-up, contact pressure molding, and spray processes or combinations thereof, according to ASTM D 4097, except as otherwise noted. In addition, inner surface and interior layer shall be constructed as required in the preceding paragraph. The exterior layer or body of the laminate shall provide the additional strength necessary to meet the tensile and flexural requirements. Where separate layers such as mat or woven roving are used, layers shall be lapped a minimum of one-inch (2-inches for woven roving). Laps shall be staggered as much as possible. If woven roving is used, a layer of chopped strand glass shall be placed as alternate layer. The exterior surface shall be relatively smooth with no exposed fibers or sharp projections. On laminates containing woven roving, cut edges exposed to the chemical environment shall be coated with resin, surfacing mat, and C-glass veil, and machined flange faces shall be faced with C-glass.

3. Outer Surface: When air-inhibited resins are cured with an air-exposed surface, a wax-containing resin coating, formulated according to the resin manufacturer's most recent recommendations, shall be used.

4. Standpipes: The manufacturer shall provide the tanks with the standpipes as shown on the drawings.

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2.4 WORKMANSHIP

A. Visual Defects: ASTM D 2563 shall be used for quality control of both filament-wound and hand lay-up construction. Acceptance levels shall be as follows:

Interior Surface	Defects
Blisters	None
Burned Areas	None
Chips	None
Cracks	None
Crazing	None
Entrapped Air	None at surface. If in laminate, 1/16-in dia max and 5/sq in max.
Exposed Glass	None
Exposed Cut Edges	None
Foreign Matter	None
Pits	Max 1/8-in dia by 1/32-in deep, max 10/sq ft.
Scratches	None (coated)
Surface Porosity	None
Wrinkles	Max deviation 10 percent of wall thickness
Sharp Discontinuity	None

Exterior Surface	Defects
Blisters	Max 1/4-in dia 1/16-in high
Burned Areas	None
Chips	Max 1/4-in with max thickness of 20 percent of wall
Cracks	None
Crazing	Slight
Dry Spots	Max 2 sq in/sq ft
Entrapped Air	1/8-in dia max; no more than 3 percent of area
Exposed Glass	None
Exposed Cut Edges	None
Foreign Matter	None if it affects the properties of laminate
Pits	Max 1/8-in dia by 1/16-in deep

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Scratches	None (coated)
Surface Porosity	None
Wrinkles	Max deviation 20 percent of wall thickness, but not exceed 1/8-in
Sharp Discontinuity	None

B. If the area fails to meet the requirements of entrapped air or voids in less than 40 percent of the total surface, those areas shall be repaired and reinspected. If the defective areas exceed 40 percent of the total surface, the entire vessel shall be rejected.

2.5 CENTER FEEDWELL/INLET PIPE SUPPORT

A. The support for the center feedwell and the inlet pipe including the connections shall be designed by the FRP tank manufacturer.

2.6 CENTER FEEDWELL

A. The center feedwell including the connections shall be designed by the FRP tank manufacturer.

2.7 BOLTS, ANCHOR BOLTS, WASHERS, AND SUPPORTS

A. The CONTRACTOR shall provide bolts, anchor bolts, nuts, washers, and supports as required for the plastic and fiberglass items in this Section, per the contract drawings, and in accordance with the requirements of the manufacturers of the plastic and fiberglass items. Bolts, anchor bolts, washers, and supports required in connection with the plastic or fiberglass items shall be of Type 316 stainless steel, Class 2, conforming to ASTM A193 for bolts and to ASTM A194 for nuts.

2.8 MANUFACTURERS, OR EQUAL

A. **Reiff Manufacturing**

B. **D&T Fiberglass, Inc**.

C. **Composites USA**

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Fiberglass reinforced plastic tanks shall be installed as shown in the drawings.

B. Pipes and equipment connecting to the tanks shall be firmly supported to avoid stresses on the tank.

C. Piping connections shall be provided with a union.

3.2 FIELD INSPECTION

A. Field inspection shall include the following:

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1. An acetone wipe test of field laminated areas to check for surface cure. No surface tackiness is permitted.

2. A Barcol hardness test of field laminated areas, at least 90 percent of manufacturer's specified hardness must be attained.

3. A hydrotest of at least 24 hours to check for leaks on field erected tanks.

END OF SECTION

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SECTION 46 41 83 – PACKED COLUMN AERATORS

PART 1 -- GENERAL

1.1 THE REQUIREMENTS

A. The Contractor shall furnish and install four (4) packed column aerators in conformance with these contract documents. The intent is for a metal fabricator to develop shop drawings and provide the fully assembled aerators based on the details in the design drawings. Each aerator consists of a column assembly with perforated distribution and retainer plates, air intake ports, media access manways structural supports, and connections for water supply piping. The aerators shall be installed with all fasteners, and all appurtenances to provide a complete working system.

B. The Contractor shall provide packing media for the aerators, filling entirely the aerator volume between the retainer plate and the distribution plate.

C. Related Work specified elsewhere:

1. Section 01 75 00 – Equipment Testing and Startup

2. Section 05 50 00 – Miscellaneous Metalwork

3. Section 46 01 00 – Equipment General Provisions

1.2 DESIGN CRITERIA

A. The aerators are intended to raise the oxygen concentration of the influent water from 6.0 mg/l to a minimum of 95% of saturation at an elevation of 20-ft msl. Each aerator shall achieve this over a range of flow from 300 gpm to 600 gpm. The maximum design hydraulic loading rate shall be 80 gpm/square foot.

B. See the contract drawings for additional fabrication details. The Contractor shall note that the aerator details on the drawings are not intended to be complete for fabrication. Contractor remains responsible for preparing shop drawings for each aerator, ensuring final fit and finish, and for provided all components and appurtenances necessary for a complete, functional assembly.

1.3 SUBMITTALLS

A. Submittals shall be in accordance with Section 01 33 00 – Contractor Submittals, and shall include the following:

B. Fabrication Shop Drawings:

1. Shop Drawings shall conform to AISC recommendations and specifications, and shall show holes, and the like, as may be required for other parts of the WORK.

2. Shop Drawings shall include complete details of members and connections, material types, weights, weld types and thicknesses, anchor bolt layouts, schedules for fabrication procedures, and diagrams for the sequence of erection.

C. Product Information:

1. Manufacturer's literature for packing media

2. Catalog cuts for other materials or accessories included as part of the tower assemblies.

D. Anchor Submittals:

1. For any post installed anchors in concrete, refer to Section 01 33 17 – Structural Design, Support and Anchorage.

E. Provide instructions for field procedures for erection, adjustments, and testing.

1.4 QUALITY ASSURANCE

A. Weld procedures and welder qualifications shall be available in the Contractor's field office for review.

PART 2 -- PRODUCTS

2.1 PACKED COLUMN AERATORS

A. Provide packed column aerators of the geometry and configuration as shown on the drawings.

B. Provide all materials, equipment, fasteners, and appurtenances necessary for the complete installation of the packed column aerators as shown on the drawing and as specified.

C. Water supply shall be a flanged connection to the tower assembly above the distribution plate. The distribution plate shall be perforated with hole sizes as indicated. The bottom media retention plate shall be perforated with hole sizes as indicated to achieve a minimum 40 percent open area. Bottom and top plates shall be removable from their respective assemblies. The upper portion of the tower shell below the distribution top plate shall have air intake ports to allow free air flow through the media.

D. The aerator assembly and base shall be fully assembled system and shall be connected by stainless steel bolts with accompanying washers and nylon locking nuts. The aerator fabricator shall consider access for tightening the bolts and shall tack weld nuts, if necessary, to allow bolt tightening from above only.

E. The aerator column shall be constructed of aluminum alloy plate and shapes with aluminum piping and fittings.

F. Aerators shall be supported by aluminum support brackets that bear on grating supports or concrete structure walls. Aerators may extend 12” below the bottom of the supports. Aerators will be supplied with all brackets, bolts, and other fasteners required for installation.

G. The media shall be P-Series 1-1/2 inch polypropylene packing rings as manufactured by The Pall Ring Company, or equivalent. The design liquid loading rate shall be maximum

80 gpm/sq ft. The media shall be provided by and be loaded into the vessel by the Contractor.

H. Provide packed aerators with manways at the location shown on the drawings. Manway gaskets shall be durometer Grade 20 neoprene.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Install in accordance with all referenced requirements, and manufacturer's directions.

1. Columns shall be delivered and installed in a specified order to allow for ongoing operations at the facility.

2. Secure to support members as required.

3. Contractor shall coordinate water supply piping around aerator installation.

4. Set in the location indicated. The aerator shall be level and plumb with no leakage at the connections.

5. Secure to the support structures as required. Provide dielectric isolation between the aerator and concrete structure or dissimilar metals with bitumastic paint or isolation gaskets.

6. Check operation while packed column aerators are in operating service.

END OF SECTION

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SECTION 46 66 63 – CLOSED VESSEL UV DISINFECTION SYSTEM

PART 1 -- GENERAL

1.1 SUMMARY

A. General: The Closed Vessel Ultraviolet (UV) Disinfection System shall include UV lamp modules, a programmable logic controller, in-channel intensity sensor systems, power distribution and data center, electrical, instrumentation and control components including spare parts and all other accessories in accordance with the requirements as specified herein.

B. The UV Disinfection System shall be U-shaped and low pressure. Like items of equipment and equipment components shall be provided by a single Supplier to ensure coordination and compatibility of equipment. The supplied UV Disinfection System shall be able to fit in the allocated space as shown in the Contract Documents.

C. The Supplier shall be responsible for detailing the interconnecting electrical and control wiring for all equipment system components furnished. All components of the UV Disinfection System shall be shipped to Site by the Supplier.

D. The dimensions of the housekeeping pad in the Water Treatment Shed shall be coordinated to match the approved UV unit. See notes on the design drawings.

1.2 CONTRACTOR SUBMITTALS

A. General. Submittals shall be prepared and transmitted in accordance with Section 01 33 00 – Contractor Submittals.

B. Shop Drawings. The following information shall be furnished with the Shop Drawings:

1. Provide shop drawings and product literature including all pertinent information for the proposed equipment such as manufacturer, capacity, type, curves, certifications, accessories, physical and performance data including dose tables, finishes, and materials. Information shall include overall dimensions, range of operating water levels, and required clearances.

    a. Where proposed equipment would result in changes to the layout presented in the Contract Documents, provide general arrangements drawings (floor plans and elevations) to scales as shown on Contract Drawings showing revised layout to accommodate the proposed equipment.

2. Provide electrical schematics and layouts, including electrical single line diagrams, schematics diagrams, and interconnection diagrams. Operating characteristics of all electrical and control equipment including power consumption, operation voltage and amperage tolerances, and ancillary electrical services shall be provided.

C. Technical Manuals – Providing technical manual for equipment in accordance with the requirements Section 01 33 00 – Contractor Submittals.

1.3 QUALITY ASSURANCE

A. The UV systems shall be from a manufacturer that has had similar systems in the same vessel configuration with the same lamps pre-validated by a third party per USEPA UVDGM or NWRI protocol.

1.4 Warranty:

A. The Contractor shall provide a Manufacturer's written warranty that provides for full replacement of all defective lamps within the first 8,760 hours of operation.

PART 2 -- PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Provide UV systems complete with control panel(s) and all accessories herein specified and indicated in the drawings.

2.2 PERFORMANCE AND CAPACITY REQUIREMENTS

A. The UV system design will meet the performance requirements of this Specification.

Identification No	UV-1 and UV-2
Location	Water Treatment Shed
No. of Vessels	2
Flow Rate per Vessel (gpm)	1,250
Configuration	Vertical, U-Shaped
Maximum Allowable Headloss per Vessel (inches)	2
Suspended Solids (mg/L)	< 25.0
Water UV Transmittance (%/cm)	90
Minimum UV Dose (mJ/cm2) at end of lamp life	130
Fouling Factor	0.87
End of Lamp Life Factor	0.8
Automatic Wiping System	Yes

2.3 DESIGN, CONSTRUCTION AND MATERIALS

A. General

1. General

2. All metal components in contact with water shall be Type 316L stainless steel.

3. All material exposed to UV light shall be Type 316L stainless steel, Type 214 quartz, HDPE, or Teflon.

4. All wiring exposed to UV light shall be Teflon coated.

B. Lamp Array Configuration

1. The lamp array configuration shall be vertical arrays with all lamps parallel to each other and parallel to the direction of flow.

2. The system shall be designed for complete immersion of the UV lamps including both electrodes and the full length of the lamp tube in the water stream. Both lamp electrodes shall operate at the same temperature and be cooled by the water stream.

C. UV Lamps

1. Lamps shall be low pressure high output, mercury amalgam type lamps.

2. UV lamps shall have a monochromatic spectral output, with the emissions peaking at 254 nanometers.

3. The type of quartz used for lamp manufacture shall be compatible with wavelength emission.

4. The operating skin temperature of the UV lamp shall not exceed 130°C.

5. UV Lamps shall not require a cool down period prior to lamp re-start, should the power to the UV system fail or be interrupted for a short period of time.

6. The filament shall be significantly rugged to withstand shock and vibration.

D. Lamp End Seal and Lamp Holder

1. Each lamp shall be enclosed in its individual quartz sleeve, one end of which shall be closed and the other end sealed by a lamp end seal and compressed O-ring. The seal shall be waterproof. The O-ring compression mechanism shall require no special tools for installation or removal.

2. The quartz sleeve shall be held in-place by means of a UV resistant retaining cup. The quartz sleeve shall not come in contact with any stainless steel frame. The lamp holder shall also incorporate a UV resistant plastic cup that shall prevent the lamp sleeve from touching the steel sleeve cup

3. In the event of a quartz sleeve fracture, the seals of the lamp holder shall prevent moisture from entering the lamp module frame and the electrical connections to the other lamps in the module.

E. UV Lamp Sleeves:

1. Clear fused quartz tubing, closed at one end shall be used. Type 219 quartz shall be used for disinfection and ozone destruction applications. Type 214 quartz also allowed.

2. Lamps shall be removable with the quartz sleeve remaining in place.

F. Automatic Wiping System

1. Provide each module with an automatic quartz sleeve wiping system, operated by the PLC control system.

G. UV Intensity Monitoring:

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1. Each UV module shall have a minimum of one (1) on-line UV intensity sensor and transmitter which responds to the germicidal portion of light as measured at 253.7 nm. The sensor shall not degrade after prolonged exposure to UV light.

2. The unit shall continuously monitor the average UV intensity in the water to be disinfected and shall transmit a 4-20 mA signal to the Programmable Logic Controller (PLC), for display via the operator interface as an absolute value in mW/cm2. The accuracy shall be ± 2% of full scale transmission. The resolution shall be ± 1% of full scale transmission.

3. Initial calibration as well as calibration instructions and necessary equipment for the calibration of the UV intensity sensor shall be supplied by the Supplier. The Supplier shall field calibrate the sensor as required, using a UV transmittance monitor. The Supplier shall otherwise factory calibrate the UV intensity sensor.

H. Temperature and Alarm Monitoring:

1. The Supplier shall supply means to protect each UV vessel from over temperature, or other damaging conditions caused by loss of water flow, overheating, etc. The unit shall signal appropriate alarms to the SCADA system.

I. Electrical Components:

1. Each UV reactor shall be powered from a remote mountable System Control Center by means of a waterproof cable interfacing with a watertight strain relief.

2. The System Control Center shall be of painted steel construction.

3. Provide transformers from the UV manufacturer if system requires voltage other than the site voltage scheduled on the Drawings.

J. Control and Instrumentation

1. System control shall be microprocessor based. Operator interface is to be display type only and be located indoors.

2. The local displays main screen shall allow the operator to view current system operating statuses; providing information inclusive of: UV intensity, UV dose, system operating hours, total number of lamps operating, power level of ballasts, and any alarm conditions. Display shall allow the operator to further view alarm conditions and history, system configuration/settings, and operation.

3. Controller shall be capable of taking in a 4-20 mA input proportional to flow in gallons per minute. Controller shall calculate dose given flow and its own intensity and shall display dose and controller shall allow user to set a low dose alarm

K. Alarm Conditions:

1. The microprocessor based local display shall allow the operator to access and view the following alarm conditions:

a. Individual lamp failure – failed lamps shall be indicated by specific address (i.e. lamp #). Position in the reactor shall be indicated via lamp numbers fixed to the lamp wiring at the service end of the UV reactor.

b. Lamp life status – at the end of UV lamp(s) lifetime the elapsed time meter will flash continually for the next 240 hours to alert the operator that all lamps in the reactor require change out. A lamp life status indicator light that changes from green to orange or red for operator attention is also acceptable.

L. Alarm Signals:

1. System shall have a normally open contact so that an alarm condition can be remotely sensed.

2.4 SPARE PARTS

A. The following spare parts shall be furnished as part of the equipment supply package.

1. 50% of Total Number of UV Lamps provided

2. 50% of Total Number of Quartz Sleeves

3. 10% of Total Number of Electronic Ballasts with plug-in connectors

4. One (1) UV Intensity Sensor

2.5 MANUFACTURERS OR EQUAL

A. PR Aqua

B. Innovasea Land Systems

C. Integrated Aqua

PART 3 -- EXECUTION

3.1 GENERAL

A. The Supplier shall submit to the Contractor equipment installation instructions a minimum of 28 Days before installation begins.

B. Equipment shall have necessary means for lifting the components into place. Components shall be lubricated at the factory as necessary to protect the equipment during shipment and storage. The UV Supplier shall be responsible for terminating all connections from the PDDC and PLC to the UV modules.

C. Contractor shall install the UV Systems per the Equipment Manufacturer's directions and the project Drawings. The Contractor will provide all required supports and anchoring required to install the UV units. The Equipment Manufacturer will provide adequate crating and protection of the UV Systems for shipment to the project site. Installation instructions will be provided that specifically outline installation of the UV system. Lifting instructions will be provided to assist the Contractor in placing the units in the mechanical room.

3.2 TESTING

A. **Factory Testing:** All major system components shall be factory tested for compliance with the construction and functional requirements specified herein. Certification of the test results shall be submitted in writing to the Contractor for each module and control panel separately, prior to shipment.

B. **Acceptance Testing:**

1. Following successful completion of the upstream equipment testing, Acceptance Testing shall begin. The Supplier shall coordinate with the Contractor to prepare and submit a detailed protocol to be followed for the Acceptance Test. Acceptance Testing shall occur during plant startup and shall be coordinated with the Contractor. The Supplier is required to be on-site during the performance testing.

2. The Acceptance Test shall include, but not limited to, the verification of the following:

   a. Maximum power consumption

   b. Delivered UV dose by measuring UV intensity and using flow meter output

3.3 START-UP AND COMPONENT VERIFICATION

A. The Contractor shall arrange to have a factory-authorized field technician to the project site for the purposes of verification and installation of the equipment and initial startup and troubleshooting.

3.4 OWNER TRAINING

A. The Contractor shall have a factory authorized field technician review the installation, operate the UV equipment using hatchery water and give 4 hours hands-on training to the Owner.

END OF SECTION

SECTION 46 99 00 – FISH CROWDER EQUIPMENT

PART 1 -- GENERAL

1.1 SCOPE OF WORK

A. This specification section covers the requirements for final design, supply, fabrication, delivery, installation, and testing of the Fish Crowding System for the South Lower Raceway, the cross-crowding channel and the Lower Rearing Pond (three total). For the purposes of this specification, the three basins (South Lower Raceway, cross-crowding channel, and the Rearing Pond) are collectively known as the Pools. The complete assembly in each of the three basins shall individually be termed “a Fish Crowder”. The nominal width of the South Lower Raceway basin is 15 feet, the nominal width of the cross-crowding channel is 5-feet, and the nominal width of the Rearing Pond basin is 40 feet.

1. The Fish Crowding System shall consist of a complete system comprised of the South Lower Raceway Crowder assembly, the cross-crowding channel assembly, and the Rearing Pond Crowder assembly. Each crowder shall consist of a single rechargeable battery-powered motor, an electric motor drive system, speed and gear reducers (as needed), hydraulic cylinders, drive wheels and rails, pulleys, walkway platform and railings, crowder leaf panels, sweeper/scraper leaf panels, cables, control operators, and other components to form a complete and operable assembly. The primary purpose of the Fish Crowder System is to move fish through the Pools to the Fish Processing Area at the upstream ends of the Pools. The secondary purpose of the Fish Crowder System is to push debris to the trench drain at the drain end of the Pools. The Fish Crowding System shall be suitable for long-term operation in a wet marine environment.

2. Each of the three Fish Crowders are designed to travel in both the forward and reverse directions in the Pools on rails positioned on the tops of the sidewalls. A rectangular-shaped crowder leaf panel or panels faced with aluminum grating is positioned on the front of the crowder carriage that spans the width and height of the basin and is raised and lowered vertically by a hoist assembly positioned on a frame. When in the lowered position in the basin, the crowder leaf panel(s) is (are) used to coax fish forward and backward horizontally in the basin.

3. A rectangular-shaped aluminum sweeper/scraper leaf panel or panels has a polypropylene bristle attachment that spans the width of the basin and is raised and lowered vertically by a hoist assembly positioned on a frame. When in the lowered position in the basin, the sweeper/scraper leaf panel(s) is (are) used to sweep debris downstream in the basin. The sweeper leaf operates independently of the crowder leaf.

1.2 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

1. ASTM INTERNATIONAL (ASTM)

a. ASTM A36/A36M: Standard Specification for Carbon Structural Steel

b. ASTM A53/A53M: Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless

c. ASTM A123/A123M: Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

d. ASTM A153/A153M: Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

e. A240/A240M: Standard Specification for Chromium and Chromium-Nickel Stainless-steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

f. ASTM A276/A276M: Standard Specification for Stainless-steel Bars and Shapes

g. ASTM A500/A500M: Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

h. ASTM A992/A992M: Standard Specification for Structural Steel Shapes

i. ASTM B209: Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

j. ASTM B429/B429M: Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube

k. ASTM D4020: Ultra-High-Molecular-Weight Polyethylene Molding and Extrusion Materials

l. ASTM F593: Standard Specification for Stainless-steel Bolts, Hex Cap Screws, and Studs

m. ASTM F594: Standard Specification for Stainless-steel Nuts

n. ASTM F1554: Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-KSI Yield Strength

o. ASTM F3125: Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength

2. AMERICAN WELDING SOCIETY (AWS)

a. AWS D1.1/D1.1M: Structural Welding Code - Steel

b. AWS D1.2/D1.2M: Structural Welding Code - Aluminum

c. AWS D1.6/D1.6M: Structural Welding Code - Stainless-steel

1.3 SUBMITTALS

A. The following shall be submitted in accordance with Section 01 33 00 – Contractor Submittals:

1. Shop Drawings

    a. Crowder Shop Drawings

2. Product Data

    a. Product Data

3. Test Reports

    a. Crowder Inspection Report

    b. Drive Motor Performance Data

    c. Rail Installation Report

    d. Operational Testing Report

4. Certificates

    a. Manufacturer Experience

    b. Crowder Installer Qualifications

5. Operation and Maintenance Data

    a. Operation and Maintenance Manuals

1.4 QUALIFICATIONS

A. The manufacturer of the Fish Crowding System shall have successfully completed projects of similar scope and size or larger, to include non-standard equipment fabrication, within the last six years. The Contractor shall demonstrate specific experience with regards to the system installation to be performed.

1.5 General Job Requirements

A. Materials and appurtenances shall be as specified and as shown on the drawings and shall be suitable for the service intended. The Fish Crowding System materials, appurtenances, and equipment supplied as part of this Contract shall be new and unused except for testing of the equipment. Components that serve the same function and are the same size shall be identical products of the same manufacturer. The general materials to be used for the Fish Crowders are indicated in the Contract Drawings.

1.6 QUALITY ASSURANCE

A. Field Verification of Dimensions

1. Make measurements/survey to field verify critical dimensions of the Pools and to ensure proper fit-up of mechanical features to the new structures and the Contractor shall advise the OWNER of any discrepancy before performing any work. Such measurements/surveys shall be performed prior to final structural detailing and fabrication. The Contractor will be held responsible for the fit-up of the mechanical features to the new structures. As-built dimensions that vary from those indicated on

the drawings will not be cause for claim against the OWNER. Verified dimensions that have the effect of altering the scope of work shall be brought to the attention of the OWNER.

B. Contractor Prepared Shop Drawings

1. Prepare and submit Shop Drawings. The drawings shall show the complete fabrication, assembly, and installation details of the Fish Crowding System. Drawings shall show detail views, with appropriate tolerances and material callouts for all fabricated parts. Unless noted otherwise, welds shall be fillet or complete penetration groove welds with matched electrodes and filler material stronger than the base metal. All components that the fabricator deems unbuildable due to interferences or insufficient clearances shall be identified on the shop drawings and resolved prior to shop drawing approval and the beginning of the work. At a minimum, the submittal shall include the following elements:

   a. Detailed drawings for each of the three crowders, including details for each unique component. Drawings shall be dimensioned as needed for fabrications and to insure fit up. Include erection weight of the crowders.

   b. Detailed drawings for the pool crowder rail system. Include views showing the concrete reinforcement and how the anchor bolts do not conflict or interfere with it.

   c. Complete details for all Contractor-designed parts.

   d. Bill of materials, including spare parts, for the entire crowder system.

   e. Lubrication schedule, including type and volume required.

C. Product Data

1. Submit complete, descriptive literature for each manufactured product used in the Fish Crowding Systems. The literature shall include original, legible, manufacturer's cut sheets/data sheets and specifications that clearly indicate physical construction, operation, mechanical and structural characteristics, and associated hardware, as applicable. Specific product model/designators used or called out in this Specification Section may not take into account all special-order features or options that are specified. Clearly indicate that submitted products include all specified features. Where products or coatings have been specified as "washdown" or "rated for continuous outdoor use", product data submittals shall show proof of that rating by the manufacturer. For data sheets with extraneous data, clearly indicate which data applies by crossing out other models or circling or highlighting the correct options. Product data shall clearly show conformance with these Specifications, including, but not limited to product manufacturers' declarations for conformance to applicable technical standards. Submit product data concurrent with the detail drawings.

D. Testing

1. All testing shall be witnessed by the OWNER or their designated representative, unless specifically waived by the OWNER. The OWNER will reserve the right to reject any test with results that do not meet the requirements of the test as stated in this Specification or the approved test plan for that test. The Contractor shall be responsible for all costs and schedule impacts due to repeating a failed test.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Materials delivered and placed in storage shall be stored with protection from the weather, excessive humidity variation, excessive temperature variation, dirt, dust and/or other contaminants. Proper protection and care of material before, during and after installation is the Contractor's responsibility. Any material found to be damaged shall be replaced at the Contractor's expense.

1.8 PROJECT/SITE CONDITIONS

A. After becoming familiar with all details of the work, the Contractor shall verify all dimensions in the field, and shall advise the Engineer of any discrepancy before performing the work.

1.9 SEQUENCING AND SCHEDULING

A. For slab, floor, wall, and roof penetrations, the Contractor shall have onsite all pertinent wall pipes and sleeves before they are required for placement in concrete forms. The Contractor shall verify and coordinate the size and location of building and structure pipe penetrations before forming and placing concrete.

PART 2 -- PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Material and quantity callouts for the Fish Crowding System are shown on the Contract Drawings, unless noted otherwise.

B. All mechanical equipment for the Fish Crowding System shall be in accordance with the requirements of specification Section 46 01 00 – Equipment General Provisions, unless noted otherwise.

C. Materials and fabrication for the Crowder Carriages shall be in accordance with specification Section 05 12 00 - Structural Steel framing.

D. Materials and fabrication for all other components must conform to the requirements of Section 05 50 00 - Miscellaneous Metalwork, unless noted otherwise.

E. Stainless-steel materials shall be Type 304/304L, unless noted otherwise.

F. Aluminum materials shall be 6061-T6, unless noted otherwise. Provide aluminum metal isolation per Section 09 96 00 at any location in contact with dissimilar metals.

G. Anchor Bolts

1. Anchor bolts shall be provided for equipment placed on concrete equipment pads, concrete slabs, or grating. Bolts shall be of the size and number recommended by the equipment manufacturer and shall be located by means of suitable templates. Installation of anchor bolts shall not degrade the surrounding concrete.

2.2 CROWDER CARRIAGES

A. Provide the Crowder Carriages per the contract drawings. The Crowder Carriages shall conform to the requirements of AWS D1.1/D1.1M, ASTM A36/A36M, ASTM A53/A53M, and ASTM A992/A992M. Fasteners shall be Hot-Dip Galvanized and conform to the requirements of ASTM A153/A153M and ASTM F3125 Grade A325. The sub-assemblies shall be Hot-Dip Galvanized in conformance with ASTM A123/A123M prior to bolting the sub-assemblies together.

B. The carriage platforms shall be galvanized steel grating as indicated on the contract drawings.

2.3 DRIVE MOTOR:

A. Drive Motor Requirements

1. The prime mover for each of the three Fish Crowders shall be a rechargeable electric battery capable of powering the drive motor to propel the fish crowder carriage in the forward or reverse direction and to also raise or lower the crowder leaf panel. The motor sizing shall be determined by the Contractor/supplier/fabricator as part of the detailed design of the Fish Crowder System. The motor power requirements shall assume the crowder travels the full length of the pool in both directions at maximum speed with the leaf panels submerged.

2. The electric drive motor for each of the crowders shall be non-ventilated and rated for outdoor usage. The electric drive motor shall conform to the latest applicable ANSI, IEEE, and NEMA standards and be rated for continuous usage suitable for the system forces resulting from the final design. The electric drive motor sizing shall be determined by the Contractor/supplier/fabricator as part of the detailed design of the Fish Crowder System. The drive system shall be operator adjustable to provide variable travel speed.

3. Submit battery and drive motor performance data including percent efficiency, amperes draw, output torque (lbf-in), percent power factor, percent slip, and RPM plotted against 0- to 280-percent rated output power, and service life.

4. The battery system shall be sized to provide power the crowder as it travels the full length of the pool in both directions at maximum speed with the leaf panels submerged at the end of a five-year life. The individual batteries shall be a maintenance free type that are commercially available within 40 miles of the project site.

5. The battery charger shall have a NEMA 5-20 plug on a cord of at least six feet long to plug into a dedicated NEMA 5-20 receptacle on shore with a weatherproof while-in-use cover. The operator will manually plug the cord into the receptacle after each crowding run. The charger shall be able to fully recharge the battery in six hours. The charger shall visible charging state indication for the operator.

B. Motor Ratings

1. The drives shall meet the following conditions:

a. Crowder:

1) Duty: Intermittent

2) Ambient Environment: Outdoor

3) Ambient Temperature, Degrees F: 0 – 105

4) Ambient Humidity: 10% - 100%

5) Minimum Power: To be determined by Contractor design

6) Carriage Travel Speed: Variable 0 to 1 fps

7) Minimum Output Torque: To be determined by Contractor design

8) Output Shaft Diameter: To be determined by Contactor design

9) Crowder Leaf Raising and Lowering Speed: 1 fps

2.4 DRIVE SHAFTS

A. Drive shafts shall be stainless-steel.

B. Drive shafts shall be 2.1875-inch diameter minimum, sized by the Contractor, and keyed to drive motor and wheels.

2.5 BEARINGS

A. Bearings shall be normal duty four bolt set screw ball bearings with Zerc fitting oriented up.

1. Coupling Sleeves

a. Coupling sleeves shall be EPDM or Neoprene.

2.6 WHEELS

A. Track Wheels

1. Crowder carriage track wheels shall be 12-inch diameter flanged steel wheels rated for at least 12,500 pound working load capacity with a keyed bore to match shafts.

B. Panel UHMW Wheels

1. Wheels on the crowder leaf panels shall be 3-inch diameter by 3-inch-wide plain bore UHMW, per ASTM D4020, with a 1,000-pound minimum working load capacity.

2.7 CROWDER RAIL SYSTEM

A. General

1. The crowder rails shall be mounted on the tops of the sidewalls of each of the three basins.

2. Each rail shall be electrically grounded.

B. Rail Section

1. Crowder rails shall be ASCE 40 pound/yard rails constructed from cast iron.

2. Web of rails shall be slotted to allow access to grease the rear wheels on the crowder carriage.

C. Rail Clips

1. The crowder rails shall be fastened to the concrete using boltable rail clips sized for ASCE 40 pound/yard rails. Rail clips shall be painted with the manufacturer's standard epoxy coating system.

D. Wheel Stops

1. Wheel stops incorporating a cushioned bumper mechanism shall be mounted at the end of each rail to limit carriage to the back and forward limits. Wheel stops shall be sized for ASCE 40 pound/yard rail.

E. Anchor Bolts

1. Anchor bolts for the rail system shall be galvanized Ubolts cast-in-place with minimum embedment as shown on the contract drawings. Contractor shall be responsible for determining the appropriate length of each anchor to allow enough thread length to adjust the rail height to tolerance.

2. Anchor bolts shall be made from galvanized U-bolt. Anchor rods shall be fully threaded with threads per ASME B1.1.

F. Grout

1. Grout used to support the rail shall be the grout recommended by the rail fastening system manufacturer.

2.8 CROWDER LEAF PANELS

A. Provide the Crowder Panel and Guides per the Contract Drawings. The fabrication and materials shall conform to the requirements of AWS D1.2/D1.2M, ASTM B209/B209M, ASTM B429/B429M, ASTM D4020, ASTM F593, and ASTM F594.

B. Crowder Screen

1. The Crowder Leaf Panels shall be made from vertically orientated 1-inch-deep x 1/8-inch-wide aluminum bar grating spaced 1-inch on center with horizontal cross bars spaced at 4-inches on center, made entirely from 6061-T6 aluminum alloy.

2. Any cut-outs shall be banded, and the panel elements and banding shall be welded to form a single unit as shown on the Contract Drawings. Welds shall be smooth, without burrs or irregularities.

2.9 HOIST CYLINDERS

A. General Requirements

1. The hoist cylinder manufacturer shall be responsible for the coordination of design, factory assembly, and testing of the hoists for the sweeper/scraper leaf; however, the contractor shall be responsible for compliance of the hoists with the Contact Documents.

2. Each hoist shall be a fixed electrical wire rope hoist of compact design, similar to Columbia Hoist, manufactured by Allied Power Products, Inc. Hoist shall be of 1 ton capacity, 15 feet lift, equipped with stainless steel rope and full electrical power and control system. Overall layout shall be as shown on the Drawings.

   a. Type: Packaged, electric wire rope hoist, fixed type bolted to the support frame.

   b. Hoist Operating Speed: Single speed

   c. Wire Rope: Stainless steel. Three (3) wraps minimum remaining on drum with hook in the lowest position.

   d. Motor: TEFC, soft start, electric drive motor with voltage and phase compatible with battery supply for crowder drive.

2.10 ELECTRICAL DESIGN CRITERIA

A. Design shall be in accordance with the following codes as enforced by the AHJ and most recently edition of the following standards:

1. NFPA 70

2. NFPA 79

3. OSHA 1910.147 Control of Hazardous Energy

4. WAC 296-46B Electrical Safety Standards, Administration and Installation

B. The crowder will be fed:

1. 120VAC electrical supply provided by a plug and cord.

C. The CONTRACTOR shall be responsible for:

1. Provision of Industrial Control Panel including:

   a. Control power supply

2. All interconnecting wiring and conduits as required

D. Ensure the control panels are placed with proper access clearance on all maintainable sides as per NEC.

E. Acceptable electrical manufacturers are listed herein.

F. Motor Variable Speed Drives (Starter/Controller):

1. Design and construct drives in accordance with the applicable sections of the following standards or as modified in this specification.

a. ANSI C84.1-1982 Voltage Ratings for Electric Power Systems and Equipment.

b. UL508A Industrial Control Equipment

c. ANSI C37-90.1-1989 Guide for Surge Withstand Capability Tests.

2. Equipment shall be approved by a recognized certification agency.

3. Equipment shall comply with the electrical bylaws of the local electrical authority.

4. Equipment shall be designed and manufactured in compliance with ISO-9001 quality standards.

5. Submit service and parts facilities information along with manufacturer's published technical data.

6. Full shop drawings to be submitted for motor drive equipment, submit as a minimum:

   a. Specification and Data Sheets.

   b. Manufacturer’s published warranty documents.

   c. Shop drawings showing plan and elevation views with certified overall and interconnection point dimensions.

   d. Interconnection wiring diagrams showing all external connections required; with all field wiring terminals marked in a consistent manner.

   e. Manufacturer’s installation instructions.

7. Motor drive shall be sized as required to meet the required motor HP, full load amperage draw and longest run time requirements.

8. The drive vendor shall be responsible for coordinating the drive and motor characteristics which shall include, but not be limited to, the following:

   a. A guarantee that the drive and motor meet the load demands and acceleration requirements of the driven equipment throughout the speed range when the input voltage varies over a range of ±10%.

   b. Ensuring complete compatibility of the drive’s current limit protection with the motor thermal withstand capability.

   c. Controlled acceleration and deceleration times, separately adjustable, shall be provided.

   d. Separately adjustable minimum and maximum speed limits shall be provided, where applicable.

   e. Drives shall be capable of regulating the speed to a ±1% of the setpoint over the full input voltage and ambient temperature operating range.

f. The vendor data shall indicate the efficiency, power factor, kW output, heat rejection and harmonic distortion of the drive at 25%, 50%, 75% and 100% operating points.

g. Audible noise levels produced by the drive shall be limited to 80 dBA sound pressure at one meter, at any point throughout the operating range of the drive.

h. When auxiliary cooling is required, the drive shall have fans and the required controls for proper operation.

9. The drive shall have control inputs and outputs as needed for the Contractor design.

10. Terminal blocks for control, alarms, metering and diagnostics shall each be readily accessible, grouped and shall be segregated from power devices, for personnel safety.

11. Each terminal block, fuse, control switch, circuit breaker, auxiliary switch, relay, instrument transformer and other auxiliary component shall be permanently labeled to correspond with the schematics and wiring diagrams.

12. The drive shall not be affected by radio frequencies emitted by portable radios/transmitters.

13. The drive shall be conformally coated

14. The drive shall protect itself against the following as a minimum:

a. Under/over voltage;

b. Overcurrent;

c. Overtemperature;

d. Output short circuit;

e. Output ground fault; and

f. Stall.

G. Control Panel:

1. Provide front access control panel, that meets the requirements listed for electrical enclosures, with white interior mounting plates. Front door shall be a vandal resistant deadfront and padlockable.

2. Control panel shall be equipped with all power supplies, power distribution, overcurrent protection, cooling fans, heating equipment, thermostats, grounding equipment, pushbuttons marshalling terminal blocks, interposing relays, controls devices, wireways, and wiring as required.

3. Control panel enclosure shall be fabricated from stainless steel. See requirements of Section 26 05 15 Industrial Control Panels.

4. Control panel shall be equipped with NEMA 4X start and stop pushbuttons, green and red respectively, 30mm heavy duty, through the panel front type.

5. Indicator light colors shall be:

    a. Green: Running

    b. Red: Stopped

    c. Amber: Alarm / Fault

6. Power distribution fuse holders, fuses, terminals, distribution blocks, and disconnects sized as required.

7. Isolated ground bar.

8. UL approved cabinet.

9. Control panel design shall protect against condensation buildup within the enclosure.

10. Wire and Cable:

    a. Analog instrumentation wiring installed in conduit or armoured cable to be twisted pair shielded cables, minimum #16 AWG copper conductors cable size, 300 Volt insulation (minimum), 100% coverage aluminum mylar shield, bare tinned copper drain wire #16 AWG minimum with overall flame retardant PVC jacket.

    b. Digital controls wiring shall utilize minimum #14 AWG copper conductors, 300 Volt insulation (minimum). When not installed in conduit, cables shall be armoured cable. Control wiring installed in conduit shall be 300 Volt or 600 Volt, type THWN, stranded copper conductors.

    c. Where multiconductor twisted pair shielded cables are installed, each pair shall be individually shielded, and the cable assembly shall have an overall shield with an inner PVC jacket, aluminum armor and outer PVC flame retardant jacket rated 300 volt.

11. All power, control and instrumentation cables shall be tagged with heat-shrunk wiretags or plastic cable tags.

12. Grounding and Bonding:

    a. Provide grounding for control panel and all equipment including instruments in accordance NEC and Electrical Inspection authority.

    b. All Grounding System Provisions will meet or exceed the requirements set out in the NEC.

    c. Use compression type fittings only

13. Acceptable electrical manufacturers are listed as follows:

    a. Electrical service, distribution equipment, and control panel:

1) ABB

2) Rockwell Automation (Allen-Bradley)

3) Schneider Electric (Square D)

4) Eaton (Cutler Hammer)

5) Hammond

6) Weidmuller

7) Omron

8) Federal Signal

9) Approved equivalent

H. All cables shall be wired through a weatherproof cord grip in the bottom of the enclosure or flexible conduit connection to allow for vibration.

ELECTRICAL AND SIGNAL WIRING

I. Size the wire per NEC Article 310. Cords shall be rated for outdoor and wet locations.

2.11 ELECTRICAL ENCLOSURES

A. Electrical enclosures shall be NEMA 4X stainless steel rated for an outdoor marine environment.

2.12 CONTROL PANELS

A. Crowder Control Panels

1. The control panel for each crowder shall be located on its crowder. Each panel shall include the control power equipment and control devices to provide manual control of all aspects of the crowder operations listed. Additional controls shall include: crowder direction and speed, leaf panel operation, and battery state indication.

PART 3 -- EXECUTION

3.1 GENERAL REQUIREMENTS

A. Carefully coordinate the final design, fabrication, and installation of the three crowders to ensure proper operation and installation tolerances shown on the Contract Drawings. Replace or repair all structural or mechanical components that do not comply with tolerances. The slotted holes in components are not intended to compensate for poor installation and quality control practices. The slotted holes are to provide the bearing alignment and minor adjustments needed for proper crowder operation.

B. Fabrication and Welding

1. All exposed edges of fabricated components shall be smooth and free from nicks, burrs, sharp edges, roll marks, and dents. Break all corners and exposed edges.

2. All fabrication for the Pool Crowder Carriages shall be in accordance with specification Section 05 12 00 – Structural Steel Framing.

3. All other fabrication and machining shall be in accordance with specification Section 05 50 00 – Miscellaneous Metalwork, unless noted otherwise.

4. Isolate all dissimilar metals.

C. Special Treatment of Surfaces to Which Fish May Be Exposed

1. All surfaces and welds shall be smooth and rounded to prevent injuries to fish. This includes, but is not limited to, any element which may be submerged or that is located within 5 feet of the water surface.

D. Mechanical Fasteners

1. Unless specified otherwise, mechanical fasteners shall be ASTM F593 hex bolts, secured with hex-nuts ASTM F594, and stainless-steel washers.

2. Torque nuts to 75 percent of the rated proof load of the fastener, unless specified otherwise.

3. All stainless-steel fasteners shall be installed with an anti-galling compound. Apply anti-galling compound per manufacturer's recommendation.

E. Painting

1. Carbon steel pieces shall be prepped and painted as specified in Section 09 96 00 - Protective Coatings. For all items to be coated, provide end caps on all open members and provide continuous seal welds at all joints and interfaces. Painting of non-ferrous and corrosion resistant materials shall not be required.

F. Galvanizing

1. Galvanizing shall be in accordance with Section 05 50 00 – Miscellaneous Metalwork. For all items to be galvanized, provide continuous seal welds at all joints and interfaces.

G. Shim Stock

1. Use stainless-steel shim stock where shimming is required.

H. Contractor Personnel Requirements

1. For elements for the crowder installation that require precise alignment, including, coupling installation and alignment, bearing alignment, crowder leveling, and rail installation, Contractor personnel shall meet the following requirements:

a. Contractor personnel shall have a minimum of five years' experience of installing, in precision alignment, mechanical systems containing shafting, bearings, couplings, speed reducers and motors.

b. Contractor personnel shall also have a minimum of five years' experience installing soft mount crane rail systems, similar to what is specified in this Section.

2. Submit Crowder Installer Qualifications detailing how the personnel selected to install the crowder system meet the requirements of the above paragraphs. Include employee names and list previous project experience that each employee has. No on-site crowder work shall take place before the Crowder Installer Qualifications are approved by the OWNER.

3. Installation and Commissioning

   a. The manufacturer's field service engineer shall be made available for commissioning of each crowder assembly for a period to include 1 day of travel and up to 2 days to confirm proper crowder assembly installation, adjustment, and operation in both automatic and manual mode. The field engineer shall be an employee of the manufacturer with a minimum of 10 years field experience in commissioning. The manufacturer's sales agents and other sales and marketing personnel will not be accepted as the manufacturer's field service engineer.

3.2 CROWDER ASSEMBLY AND INSTALLATION REQUIREMENTS

A. General

1. Weldments for the crowder system components shall be fabricated in the shop. Sub-assemblies may be put together in the shop or on-site.

B. Flexible Couplings and Bearings

1. Install flexible couplings per the manufacturer's instructions. Coupling halves shall be properly spaced, per manufacturer's specifications, and measured with feeler gauges before final assembly.

2. Install bearings on shaft per the manufacturer's instructions.

3. Verify that bearings and couplings are within, and not near the limit of their misalignment capabilities. If couplings and bearings are found to be at the limit of their misalignment capabilities, the machinery shall be re-aligned.

C. Tolerances and Clearances

1. The crowders shall be fabricated such that the wheels are within 0.25 inches of clear from the rails and the brushes are within 0.25 inches of the side walls of the concrete wall and that the brushes can be adjusted to just touch the tank walls when installed.

D. Factory Testing

1. The Contractor shall notify the OWNER 2 weeks prior to providing the factory testing. The manufacturer shall demonstrate in the factory that the crowders roll smoothly along a rail and the hoists can raise and lower the panels from their fully lowered to their fully raised position and from their fully raised to their fully lowered position.

2. All surfaces shall be made available for inspection to verify all surfaces that may be exposed to fish are smooth and rounded to prevent injuries to fish.

3.3 RAIL SYSTEM INSTALLATION

A. General

1. The crowder rail on each side of the basins shall not vary in alignment by more than ¼ inch from its lowest point to its highest point. The crowder rails shall be spaced at the distance shown on the drawings within 1/8 inch plus or minus. The crowder rails on the opposite sides of the pool or tank shall not vary in elevation by more than ¼ inch.

B. Rail Alignment

1. Before pouring grout, verify the distance between the pool floor and top of rail and the rail gauge every 10 feet of rail length. Submit a Rail Installation Report that shows the specified tolerances have been achieved. The report shall include the following at a minimum:

a. Rails for the specific Fish Crowder shall be included in the report.

b. Contractor personnel involved in the installation and tolerance verification.

c. Measurement instruments used to verify installation tolerances and proof of current calibration.

d. The measured value of the distance between the floor of the basin and the top of the rail every 10 feel of rail length. Show measurements on an elevation view drawing of each rail and pool.

e. The measured value of the rail gauge every 10 feet of rail length. Show measurements on a plan view drawing of each rail and basin.

2. Once the Rail Installation Report has been approved, the Contractor shall pour the grout and properly torque the anchors.

3.4 OPERATIONAL TESTING

A. General

1. Each piece of the Fish Crowders described in this section shall be field tested before it will be accepted by the OWNER. Field tests shall consist of operating the equipment in the manner it was designed to operate. The OWNER shall be notified five days before a test is to occur so that the tests can be witnessed by the OWNER, or an alternate identified by the OWNER. Testing shall not occur without the presence of the OWNER, or an alternate identified by the OWNER. All deficiencies discovered during testing shall be corrected, and then retesting shall be conducted until satisfactory results are attained. Specific operational testing requirements for each piece of equipment are listed below.

2. Operational testing of the crowder system shall occur in two phases; the first where the basins are dry, and the second where the system is fully watered up.

3. During the operational tests, improper operation or poor condition of safety devices, electrical components, mechanical equipment, and structural assemblies shall be monitored by the Contractor. Observed defects critical to continue testing shall be reported immediately to the OWNER or their designated representative and testing shall be suspended until the deficiency is corrected. The Contractor shall determine which component is causing problems. If directed, the Contractor shall correct problems with existing equipment.

4. If defects, such as misalignment, improper adjustment, overheating, or other defects which can damage the crowders, become apparent the tests shall be discontinued until proper action has been taken to correct the conditions. After corrective action has been taken, the tests shall continue or be rerun as directed.

B. Pre-testing Requirements

1. The following shall be completed before any operational testing may occur for each crowder that is to be tested:

a. The brushes have been properly adjusted.

b. The Rail Installation Report has been approved by the OWNER or their designated representative.

c. All gearboxes shall be filled with new filtered oil to the correct level.

d. Bearings and flexible couplings shall be greased per manufacturer's instructions with new grease of the specified type.

e. Damaged surface coatings incurred during shipment and/or installation shall be repaired to the satisfaction of the Engineer prior to installation.

C. Dry Operation Testing

1. General

a. Prior to filling its respective basin, the crowder system component adjustment and operational testing shall be performed.

2. Dry Operational Testing Procedure and Requirements

a. The Contractor shall perform two crowding cycles with each crowder system component for dry operational testing. A crowding cycle shall be considered as the following:

1) The crowder shall start in its parked position with the panel at its upper limit.

2) The crowder shall travel into position where the back side of the panel is aligned within 1-inch horizontally from the downstream end of the basin. The panel then can be lowered to the crowding position with the wheels on the basin concrete slab.

3) The crowder shall travel the full length of the basin until it has reached its wheel stop.

4) The crowder shall be in parked position with the crowder leaf panel at its lower limit.

5) The crowder components are moved back to their starting positions.

b. During each cycle verify the following:

1) Verify that the vertical drive train does not bind, chatter, or produce abnormal noises or vibrations during operation.

2) Verify horizontal drive train does not bind, chatter, or produce abnormal noises or vibrations during operation.

3) Check for overheating of motors, brakes, speed reducers, and bearings.

4) While lowering the panel at the start of the cycle, stop the lowering operation in the middle of travel and ensure proper brake operations.

5) Test and inspect all safety devices, including emergency stop switches.

6) Verify that the crowder panel, including the perimeter rubber belting or nylon brushes, do not bind in the basin walls or floor during any point of operation.

D. Wet Operational Testing Procedure and Requirements

1. After filling its respective basin, the crowder wet testing shall be performed. Requirements for wet operational testing shall be the same as dry operational testing.

E. Operational Testing Report

1. Submit an Operational Testing Report after operational testing is complete. The Operational Testing report shall contain the following information at a minimum:

a. Notate the date and which crowder the test occurred on, as well as all Contractor personnel that were involved in the test. Include model and serial number of any measuring equipment used.

b. Documented proof that the inspections listed above were successfully made during the tests.

c. Any abnormalities or issues in operation such as excessive vibration, noise, or heat discovered during testing, including measures taken to correct any issues.

3.5 OPERATION AND MAINTENANCE MANUALS

A. In accordance with the requirements set forth in Section 01 77 00 - Closeout Procedures, complete operating and maintenance data regarding the Fish Crowders shall be submitted as part of the O&M manual. Operation manuals shall detail the step-by-step procedures required for specialized startup, operation and shutdown of systems, and shall include the manufacturer's name, model number, parts list, and brief description of equipment such as valves and other appurtenances and their basic operating features. Maintenance manuals list routine maintenance procedures and troubleshooting guides for the equipment. In addition to the requirements of Section 01 77 00 – Closeout Procedures, include copies of all test reports in the O&M manuals.

END OF SECTION

SECTION 46 99 10 FISH COUNTER EQUIPMENT

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide fish handling equipment and appurtenances, complete and operable, in accordance with the Contract Documents. Fish handling equipment shall include:

1. Fish Counter (FC-1)

B. The requirements of Sections 41 00 00 – Equipment General Provisions and 43 30 00 – Valves and Gates apply to this Section.

C. All fish equipment will require special finishing and treatment to ensure there are no sharp corners, edges or other projections. The drawings and specifications show schematically the intended configuration and performance requirements. The CONTRACTOR shall provide necessary additional design and detailing necessary to complete the detailed design of the components to provide operable, fish safe equipment suitable for long tern operation in a harsh outdoor environment.

1.2 CONTRACTOR SUBMITTALS

A. General: Submittals shall be furnished in accordance with Section 01 33 00 - Contractor Submittals.

B. Shop Drawings: Provide shop drawings and product data for all equipment including but not limited to:

1. Engineering drawings and details for main rail, supports, anchorage, mounting equipment, etc.

2. Submit shop drawings for all metal fabrications prior to shop fabrication.

3. Submit catalog cuts for all system components.

C. Technical Manuals: Provide operating and maintenance manuals in accordance with Section 01 77 00 – Closeout Procedures.

D. Tools and Spare Parts: The CONTRACTOR shall supply one complete set of special wrenches or other special tools necessary for the assembly, operation, adjustment, and dismantling of the equipment. All tools shall be of best quality and furnished in labeled toolboxes of suitable design.

PART 2 -- PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Furnish all connectors, fasteners, welded metal, and miscellaneous items required to complete and construct the items shown on the drawings.

B. Unless otherwise shown, all fasteners shall be suitable for submerged or "wet locations" and shall be stainless steel in accordance with Section 05 50 00 – Miscellaneous Metals.

C. Furnish washers and lock washers for all bolted connections unless otherwise noted.

Washers and lock washers shall be of the same material as fasteners and connectors.

D. Furnish stainless steel anchor bolts, expansion anchors or epoxy anchors of the sizes shown on the drawings. Bolts and anchors shall conform to the requirements of Section 05 50 00 – Miscellaneous Metals.

E. Furnish guards where required by OSHA regulations for open gearing, pinch points etc.

2.2 FISH COUNTER (FC-1)

A. Provide One (1) automated fish counting systems including a sensing element, electronic controller, and fabricated aluminum mounting frame that can be installed as shown on the drawings.

B. The system shall be completely self-contained and portable for installation by the OWNER in two or more locations requiring only connection to a 110-volt, 1-phase, 60Hz power receptacle. The counter shall record the number of fish, date, time, and water temperature. The unit shall be capable of recording and storing data for downloading to a portable PC and be capable of viewing real-time information from any mobile device. The counter shall be supplied with all necessary software to setup, calibrate, and operate, analyze, and view the data in real-time. Provide two (2) connector cables at least 5 ft. in length to connect a standard laptop computer to the data collector. Provide a minimum 30 ft of lead wire between the sensor and the controller. The controller shall be mounted in a NEMA 4, lockable enclosure.

C. The fish counter shall each be a **Macro Counter** as manufactured by **Vaki Aquaculture Systems Ltd.**, Kópavogur, Iceland, or approved equal.

D. Stainless steel pipe, tubing, and structural shapes necessary to support the trough shall be Type 316 in accordance with the applicable portions of Section 05 50 00 – Miscellaneous Metals.

E. The Contractor and manufacturer shall coordinate all aspects of this assembly to ensure a secure and functional system, attachments, and compatibility with other related equipment.

F. Panel mounting shall be provided and secured to either nearby handrail or posts dedicated for the panels at the Spawning Shed. The intent is to remove counter units in the off season and in anticipation of flood events. The control panel attachments and power connections shall be designed by the manufacturer to allow the fish counter units and panels to be rapidly disconnected and removed from service. Control panel enclosure shall be fabricated from stainless steel.

PART 3 -- PART 3 - EXECUTION

3.1 GENERAL

A. **Coordination**: The fabricators of the various equipment shall provide detailed fabrication drawings and layouts for coordination of the related systems to ensure that the completed facility functions as shown and specified.

3.2 FABRICATION

A. All sharp corners, edges and welds shall be rounded or ground smooth to prevent injury or abrasion to the fish.

B. Welding and machining shall be in accordance with Section 05 50 00 - Miscellaneous Metals.

3.3 TESTING

A. Proper operation of the systems shall be demonstrated by the Contractor to ensure its suitability for operation, safety, and conformance to the requirements of this specification. The following tests shall be performed:

1. Fish counter operation shall be fully demonstrated by the manufacturer's representative. On-site services shall be provided for one – 40 hr week on-site during fish migration periods to install and interrogate the system and provide training to the OWNER'S personnel on the use of the system and the collection and interpretation of the data generated by the system.

2. Mechanical tests: Proper operation and adjustment of the system shall be demonstrated.

B. The Contractor shall instruct the OWNER'S staff in the proper operation and adjustment of the fish handling systems.

END OF SECTION

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SECTION 46 99 20 – FISH BUCKET CONVEYOR

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide one Fish Bucket Conveyor (also referred to as the Fish Carcass Elevator) including structural framing, piping, wiring, drives, control panel, and associated appurtenances, complete and operable, in accordance with the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

A. **General:** Submittals shall be furnished in accordance with Section 01 33 00 - Contractor Submittals.

B. **Shop Drawings**: Submit shop drawings of Fish Bucket Conveyor containing the following minimum information:

1. Descriptive literature including detailed description and materials specifications

2. Performance data

3. Electrical data including control and wiring diagrams, electrical characteristics and connection requirements

4. Assembly and installation drawings including support requirements, attachment point details, parts nomenclature, material list, outline dimensions and shipping and operating weights

5. One year manufacturer's warrantee

C. **Operation and Maintenance Manual**: Submit an operations and maintenance manual in accordance with Section 01 77 00 – Closeout Procedures for the Fish Bucket Elevator containing the following minimum information:

1. Installation instructions, assembly views, lubrication instructions, and replacement parts list

2. Routine maintenance and adjustment instructions and schedule

3. Operation instructions including starting, stopping, and guidance for optimum operation

1.3 DELIVERY, STORAGE AND HANDLING

A. Provide shipping covers to keep foreign materials out of equipment. Handle equipment carefully to prevent damage. Store equipment inside and protected from the weather.

1.4 SPARE PARTS

A. Three spare buckets

B. Ten (10) linear feet of spare chain

C. Two (2) bearings

1.5 QUALITY ASSURANCE

A. All equipment specified and furnished under this section shall be provided by a single manufacturer, who shall have overall responsibility for the functionality and adequacy of the completed product. The design of the system in its entirety shall be the responsibility of the manufacturer, including the hydraulic power system, conveyance system, and structural support of the Fish Bucket Conveyor.

B. Provide the services of a manufacturer's representative to supervise the installation of the Fish Bucket Conveyor and to provide start-up and field testing. The manufacturer's representative shall also instruct the Tribe's staff on the operation, adjustment, and maintenance of the Fish Bucket Conveyor. The manufacturer's representative shall return to the hatchery during the spawning season to observe the operation of the Fish Bucket Conveyor, make any necessary adjustments and provide guidance to the hatchery staff on its optimum operation. This visit shall be scheduled with the hatchery manager to coincide with actual operation of the Fish Bucket Conveyor.

2.6 Manufacturers, or Equal

A. **Ryco Equipment, Inc.**
6810 220th St. SW
Mountlake Terrace, WA 98043
(425) 744-0444

PART 2 -- PRODUCTS

2.1 GENERAL REQUIREMENTS

A. **Identification**:

1. Equipment Name - Fish Bucket Conveyor
2. Equipment Number - ME-1
3. Quantity - 1

B. **Operating Conditions:** The WORK of this Section shall be suitable for long term operation under the following conditions:

1. Duty - Continuous
2. Drive - Constant speed
3. Ambient environment - Outdoors
4. Ambient temperature - 20° to 100° degrees F

5. Fluid temperature - 32° to 65° degrees F

6. Project site elevation - 50 ft

C. **Performance Requirements**:

1. Holding Pond Operating Range - See Drawings

2. Discharge Elevation - See drawings, coordinate with Owner on clearance for bin/tote and table

3. Motor size (hp) - Per manufacturer

D. **Conveyor Output - Dimensions:**

1. Processing Capacity - 40 to 60 fish/minute

2. Lift (Appx) - 12 ft

3. Horizontal Travel Distance (appx) - 5.5 ft

4. Belt Width (Appx) - 24-inches

5. Scoop Flight Depth - 4-inches at 12-inches on center

E. The Fish Bucket Conveyor shall consist of a complete system designed to lift adult salmon and steelhead trout up to 50 pounds in weight. The Fish Bucket Conveyor shall lift the fish from the spawning shed sump at floor level, and discharge them on the sorting table on the opposite side of the equipment as shown on the drawings.

F. The system shall consist of a belt conveyor, structural frame and supports, electric drive system and drive belts, controls and lift system, entrance screen, and all moldings, fasteners, support wheels, and related items for a complete and operable unit.

G. The direction and speed of the Fish Bucket Conveyor shall be controlled by a electric drive system.

2.2 MATERIALS

A. The conveyor belt shall be made of Intralox Series 800 open hinge segmented polyethylene.

B. The main frame and supports shall be fabricated from marine grade aluminum and UHMW material. The entrance screen shall be aluminum punched plate welded to the net guard and supported at its perimeter with aluminum tube. Assembly hardware shall be stainless steel.

C. Control Panel: The control panel shall meet the requirements of Section 26 05 15 and other applicable sections of Division 26. Panel shall be fabricated from Stainless Steel. Provide motor starters and a 480VAC, 3 phase disconnect switch. Provide thermal overloads, control power transformer (CPT), control switches and lights. A power cable and plug with 50-feet of cable shall be supplied.

PART 3 -- EXECUTION

3.1 GENERAL REQUIREMENTS

A. All parts of the equipment shall be conservatively proportioned for stresses that may occur during fabrication, erection and intermittent or continuous operation. Workmanship shall be of the highest quality in all respects.

B. The Fish Bucket Conveyor shall be completely assembled and tested in the shop prior shipping.

3.2 INSTALLATION

A. Installation shall be in accordance with the shop drawings, and manufacturer's written instructions.

3.3 SERVICES OF MANUFACTURER

A. **Inspection, Startup, and Field Adjustment:** The service representative of the Manufacturer shall be present at the Site for 1 workday for startup and testing and to furnish the services required by Section 01 75 00 – Equipment Testing and Startup.

B. **Instruction to Staff:** The training representative of the Manufacturer shall be present at the Site for 1 additional workday to provide training on the proper use and maintenance of the equipment.

C. For the purposes of this paragraph, a workday is defined as an eight-hour period at the Site, excluding travel time.

D. The OWNER may require that the inspection, startup, and field adjustment services above be furnished in two separate trips.

END OF SECTION