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DRAWINGS
Plan Sheets as Prepared by KSA Engineers, Inc.
DIVISION 01000
GENERAL
PART 1 GENERAL

1.1 SECTION INCLUDES

A. Contract Description
B. Contractor Use of Site and Premises

1.2 CONTRACT DESCRIPTION

A. Work under this contract includes:

   Installation of ozone disinfection system including ozone generator, contact tank, yard piping, electrical, controls, and appurtenances.

1.3 WORK SEQUENCE

A. Construct Work in phases to accommodate Owner's requirements. During the construction period, coordinate construction schedule and operations with Engineer.
B. Retainage shall be withheld until final completion and Owner acceptance of the entire project.

1.4 CONTRACTOR USE OF SITE AND PREMISES

A. Limit use of site and premises to allow:
   1. Owner occupancy and operation
   2. Work by others and work by Owner

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES

A. The work to be performed under this Section shall consist of furnishing all permits, preparation, and implementation of a site specific Storm Water Pollution Prevention Plan, notice of intent, notice of termination, labor, equipment, materials, and pay all permit fees as necessary to meet the requirements of the Texas Pollution Discharge Elimination System (TPDES) associated with construction activities under TPDES Construction General Permit TXR150000 for storm water pollution prevention as required by current Federal, State, and Local rules and regulations as shown and specified.

1.2 SUBMITTALS FOR INFORMATION

A. The following items shall be submitted for record purposes only. These documents will not be reviewed for compliance with permit requirements.

1. Storm water pollution prevention plan,

2. Notice of Intent (NOI),

3. Photocopies of permit application fee payment(s), and

4. Notice of Termination (NOT).

1.3 GENERAL PERMIT, APPLICATION, AND FEES

A. The Contractor shall bear sole responsibility for the storm water pollution prevention provisions of this Contract as well as bear sole responsibility for development, implementation, and maintenance of the storm water pollution prevention plan, the best management practices, and the facilities utilized to meet the TPDES General Permit requirements. The storm water pollution prevention plan and Notice of Intent shall be completed prior to beginning any work or stockpiling of materials.

B. Prior to filing the Notice of Intent, the Contractor shall develop and submit a project specific storm water pollution prevention plan based on best management practices that includes all aspects as required by current Texas Commission on Environmental Quality (TCEQ) and US Environmental Protection Agency (USEPA) rules.

C. After submittal of a Project specific storm water pollution prevention plan as required by TXR150000, the Contractor shall file the Notice of Intent (NOI). A copy of the NOI shall be submitted to the Engineer for record purposes.
D. The Contractor shall pay all fees, including initial application and renewal fees, associated the TPDES permit application. A photocopy of the payment shall be submitted to the Engineer.

E. The Contractor shall pay all costs associated with the development of the storm water pollution prevention plan as well as the implementation, maintenance, monitoring, and inspection of the storm water pollution prevention plan facilities during the construction period.

F. Upon closeout of the Project, the Contractor shall submit at Notice of Termination (NOT) to the TCEQ using the proper form and provide a copy to the Engineer or record purposes.

1.4 SWPPP REQUIREMENTS

A. The Storm Water Pollution Prevention Plan shall comply with the requirements of TPDES Construction General Permit TXR150000. For additional information contact the Texas Commission on Environmental Quality at P. O. Box 13087, Austin, TX 78711-3087 or on the web at http://www.tceq.state.tx.us

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION
PART 1 GENERAL

1.1 WORK INCLUDED:

A. Furnish labor, materials, equipment and incidentals, including pumps, piping and other facilities necessary to remove surface and groundwater as needed to perform the required project construction.

B. Build and maintain the necessary temporary impounding works, channels, and diversions.

C. Remove the temporary works, equipment, and materials after they have served their purpose in strict accordance with this section of the specifications and the applicable drawings.

1.2 SUBMITTALS:

A. Plans and procedures for handling flood flows and dewatering excavations. Submit plans and procedures to Engineer for approval.

B. Any construction modifications to the system shall also be submitted.

C. Approval of plans and procedures for handling flood flows and dewatering does not relieve the Contractor of full responsibility and liability for care of water during construction.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.1 EXECUTION:

A. Flood Flows and Other Water:

1. The Contractor shall be responsible for handling and diverting any flood flows, stream flows, or any other water, including groundwater encountered during the progress of the work.

2. Build, maintain, and operate cofferdams, channels, flumes, sumps, and other temporary works as needed to pass floodwater, divert stream flow, or pass other surface water through or around the construction site and away from construction in progress.

3. Unless otherwise approved by the Engineer, a diversion must discharge into the same natural watercourse in which its headworks are located.
4. Construct permanent work in areas free from water.

5. The removal of protective works, after having served their purpose, shall be in a manner satisfactory to the Engineer.

B. Dewatering Excavated and Other Foundation Areas:

1. The Contractor shall be responsible for dewatering foundations for all areas during construction of the works of improvement, including areas of required backfills.

2. Lower the water table as needed to keep those areas free of standing water or excessive muddy conditions.

3. Furnish the drains, sumps, casings, well points, and other equipment necessary to dewater areas for required construction work.

4. Any dewatering method that causes loss of fines from foundation areas will not be permitted. Keep available standby equipment to provide proper and continuous operation of the dewatering system.

5. Provide continuous monitoring (24 hours per day) of the dewatering system to provide continuous operation.

C. Dewatering Borrow Areas: Unless otherwise specified on the drawings, maintain the borrow areas in drainable condition or otherwise provide for timely removal of surface waters that accumulate for any reason, within the borrow areas.

END OF SECTION
DIVISION 02000
SITE WORK
DUNDEE STATE FISH HATCHERY OZONE SYSTEM  
PROJECT NUMBER 128632  

SECTION 02100  

EROSION AND SEDIMENT CONTROL DURING CONSTRUCTION  

PART 1 GENERAL  

1.1 SECTION INCLUDES  

Furnish labor, materials, equipment, and incidentals necessary to provide erosion and sediment control for the duration of the construction period including furnishing, installing, and maintaining erosion and sediment control structures and procedures and the proper removal when no longer required.  

The intent of this specification is to provide guidelines for the Contractor to adhere to all state, federal, and local environmental regulations. It is also the intent to provide preventive measures to keep sediment from entering any storm water system including open channels. It is the Contractor's responsibility to adhere to all federal, state, and local requirements. While the Engineer may require the Contractor to install erosion control devices during construction, this will in no way relieve the Contractor of his responsibility.  

1.2 RELATED SECTIONS  

A. UGC Article 8 – Quality Control; Submittals  

B. Section 02370 – Erosion Control Fabric  

C. Section 02375 – Filter Fabric Fence  

D. Section 02380 – Sediment Logs  

E. Section 02936 – Seeding  

1.3 SUBMITTALS  

Submittals shall be in accordance with UGC Article 8 – Quality Control; Submittals. Data describing all materials incorporated into the project is required for all of the various erosion and sediment control devices. Manufacturers’ product data sheets shall be provided for manufactured products.  

1.4 QUALITY ASSURANCE  

A. Comply with applicable requirements of all governing authorities having jurisdiction. The specifications and the plans are not represented as being comprehensive, but rather convey the intent to provide complete slope protection and erosion control for both the Owner’s and adjacent property.  

B. Erosion control measures shall be established at the beginning of construction and maintained during the entire length of construction. On-site areas which are subject to
severe erosion and off-site areas which are especially vulnerable to damage from erosion and/or sedimentation are to be identified and receive additional erosion control measures as directed by the Owner, Engineer, or Project Representative.

C. All land-disturbing activities shall be planned and conducted to minimize the size of the area to be exposed at any one time, to minimize the time of exposure, and to minimize off-site sedimentation damage.

D. Surface water runoff originating upgrade of exposed area shall be controlled to reduce erosion and sediment loss during the period of exposure.

E. When the increase in the peak rates and velocity of storm water runoff resulting from a land-disturbing activity is sufficient to cause accelerated erosion of the receiving ditch or stream, the Contractor shall install measures to control both the velocity and rate of release so as to minimize accelerated erosion and increased sedimentation of the stream as directed by the Owner, Engineer, or Project Representative.

F. The Contractor shall be responsible for periodically cleaning out and disposing of all sediment once the storage capacity of the drainage feature or structure receiving the sediment is reduced by one-half unless otherwise specified. The Contractor shall also be responsible for cleaning out and disposing of all sediment at the time of completion of the project.

G. Inspect all erosion and sediment control measures after each rainfall or daily during periods of prolonged rainfall. Inspection shall occur at least once a week during rainless periods. Correct any erosion and sediment control measures that do not conform to specifications and details.

1.5 JOB CONDITIONS

Comply with the local, state, and federal codes and ordinances. If the codes and ordinances require more stringent or additional erosion and sediment control measures during construction than those specified or shown on the plans, the Contractor shall provide such measures.

PART 2 PRODUCTS

2.1 STRAW BALES

Straw bales shall weigh a minimum of fifty pounds and shall be at least thirty inches in length. Bales shall be composed entirely of vegetable matter and be free of seeds. Binding shall be either wire or nylon string. Jute or cotton binding is unacceptable. Bales shall be used for no more than three months before being replaced. However, if weather conditions cause biological degradation of the straw bales, they shall be replaced sooner than the three month time period to prevent a loss of structural integrity of the straw bale dike.
2.2 SILT FENCE

Provide woven geotextile filter fabric made of polypropylene, polyethylene, ethylene, or polyamide material. Geotextile fabric shall have a grab strength of 100 psi in any principle direction (ASTM D4632); Mullen burst strength exceeding 200 psi (ASTM D3786), and the equivalent opening size of between 20 and 50. Silt fence material shall contain ultraviolet ray inhibitors and stabilizers to provide a minimum of six months of expected usable construction life at a temperature range of 0° F to 120° F. Silt fence shall have galvanized welded wire mesh (12.5 gauge minimum, two inch by four inch maximum opening) as backing to provide support. Silt fence posts shall be 1.00 – 1.33 lb/linear foot steel posts.

2.3 SANDBAGS

Sandbag material shall be polypropylene, polyethylene, polyamide, or cotton burlap woven fabric with a minimum unit weight of four ounces per square yard; a Mullen burst strength exceeding 300 psi, and ultraviolet stability exceeding 70 percent. Length shall be 24 to 30 inches. Width shall be 16 to 18 inches. Thickness shall be six to eight inches. Filled sandbags shall have an approximate weight of 90 to 125 pounds. Sandbags shall be filled with coarse grade sand that is free from deleterious material. All sand shall pass through a No. 10 sieve.

2.4 PVC PIPE

Pipe shall be SDR-35 polyvinyl chloride having a minimum nominal diameter of four inches. Pipes shall be sized for anticipated flows in a two-year return period storm.

2.5 SOIL RETENTION BLANKET

Soil retention blankets shall consist of a geocomposite of excelsior or fiber blanket with an extruded plastic net. The plastic net shall be photodegradable and the excelsior or fiber blanket shall be made smolder resistant without the use of chemicals. Soil retention blankets shall be high velocity type to resist severe runoff. Soil retention blankets shall be American Excelsior Company Curlex Blanket or Engineer approved equal.

2.6 ROCK FILTER DAM

A. All aggregate used for the construction of rock filter dams shall be hard, durable, clean, open-graded, and shall naturally resist crumbling, flaking, and eroding. Aggregate gradation shall be three to six inches for rock filter dams Types 1 and 2 and shall be four to eight inches for Type 3.

B. The galvanized steel wire mesh for Types 2 and 3 rock filter dams shall be a minimum 20 gauge and have 1” diameter hexagonal openings unless specified otherwise on the plans. Tie wires shall be a minimum 20 gauge.
2.7 STABILIZED CONSTRUCTION EXIT

Aggregate used in stabilized construction exits shall be hard, durable, clean, open-graded, angular, and have a nominal diameter of four inches.

PART 3 EXECUTION

3.1 INSTALLATION

A. STRAW BALE DIKE

1. Straw bales shall be embedded a minimum of four inches and securely anchored using 2" x 2" wood stakes driven through the bales into the ground a minimum of six inches. Straw bales are to be placed directly adjacent to one another leaving no gap between them.

2. Bales shall be placed in a single row lengthwise on proposed line with the ends of adjacent bales tightly abutting one another. In swales and ditches, the barrier shall extend to such a length that the bottoms of the end bales are higher in elevation than the top of the lowest middle bale. Additional bales shall be placed behind the first row where the bales abut each other. The additional bales are used to prevent unfiltered runoff from escaping between the bales.

3. The excavated soil shall be backfilled against the barrier. Backfill shall conform to ground level on the downhill side and shall be built up to 4 inches above ground level on the uphill side. Loose straw shall be scattered over the area immediately uphill from a straw bale dike.

B. SILT FENCE

1. Provide silt fence systems at locations specified in accordance with the drawings and as necessary to prevent sediment from leaving the site. Silt fence shall be installed in such a manner that surface runoff will percolate through the system in sheet flow fashion and allow sediment to be retained and accumulated.

2. Silt fence should not be used where there is a concentration of water in a channel or drainage way or where soil conditions prevent a minimum toe-in depth of six inches or installation of support posts to a depth of 12 inches. If concentrated flow occurs after installation, corrective action must be taken such as placing a rock filter dam in the areas of concentrated flow.

3. Attach the fabric and wire backing to steel posts spaced no more than six feet apart and embedded at least 18 inches deep. Steel posts shall have projections for fastening wire and/or fabric.
4. Trench in the toe of the filter fabric fence with a spade or mechanical trencher so that the downstream face of the trench is vertical. The trench shall be a minimum of six inches wide and six inches deep. Lay filter fabric and wire along the bottom and downstream wall of the trench. Backfill and compact the trench.

5. The filter fabric and wire backing should be provided in continuous rolls and cut to the length of the silt fence to minimize the use of joints. When joints are necessary, the fabric and wire should only be spliced together at a support post and have at least six inches of overlap. The joint shall be securely sealed.

6. Unless otherwise directed, maintain the silt fence until the project is accepted by the Owner. Remove promptly in an appropriate manner when directed by the Owner.

7. Remove and dispose of sediment deposits off-site. Off-site disposal will be the responsibility of the Contractor. Sediment shall not be allowed to flush into streams or drainage ways. If sediment has been contaminated, it shall be disposed of in accordance with local, state, and federal regulations.

8. Inspection of silt fences shall occur after each rainfall or daily during periods of prolonged rainfall. Inspection shall occur at least once a week during dry periods. Repair or replace damaged sections immediately to bring the silt fence back into compliance with the plans and specifications. Sediment deposits shall be removed when they reach one-third of the height of the fence.

C. SANDBAG BERM

1. The purpose of a sandbag berm is to intercept sediment-laden water from disturbed areas such as construction in steam beds, create a detention pond, detain sediment, and release water in sheet flow.

2. A temporary sandbag berm shall be installed across a channel or right of way in a disturbed area and should be used when the contributing drainage area is greater than 5 acres. The berm shall be a minimum height of 18 inches measured from the top of the existing ground at the upslope toe to the top of the berm. The berm shall be sized to have a minimum width of 48 inches measured at the bottom of the berm and 18 inches measured at the top of the berm.

3. The sandbag berm shall be inspected after each rain or daily during periods of prolonged rainfall. The sandbags shall be reshaped or replaced as needed. Additional inspections shall be made weekly during dry periods. When the silt depth reaches six inches, the accumulated silt shall be removed and disposed of at an approved site in a manner that will not contribute to additional
sedimentation. The sandbag berm shall be left in place until all upstream areas are stabilized and accumulated silt is removed.

D. SOIL RETENTION BLANKET

1. A soil retention blanket is a geotextile or biodegradable fabric placed over disturbed areas to limit the effects of erosion due to rainfall impact and runoff across barren soil. Soil retention blankets are manufactured by a wide variety of vendors addressing a wide variety of conditions such as vegetation establishment and high velocity flow. Blankets are used in areas which are difficult to stabilize such as steep slopes, drainage swales, or high pedestrian traffic areas.

2. The soil retention blanket, whether installed as slope protection or as flexible channel liner, shall be placed within 24 hours after seeding or sodding operations have been completed or as approved by the Engineer. Prior to placing the blanket, the area to be covered shall be relatively free of all rocks or clods over 1-1/2 inches in maximum dimension and all sticks or other foreign material which will prevent the close contact of the blanket with the soil. The area shall be smooth and free of ruts, and other depressions. If, as a result of rain, the prepared bed becomes crusted or eroded or if any eroded places, ruts, or depressions exist for any reason, the Contractor shall be required to rework the soil until it is smooth and to reseed or resod the area at the Contractor's expense.

3. Installation and anchorage of the soil retention blanket shall be in accordance with the manufacturer's recommendations.

E. INTERCEPTOR DIKE

1. Install interceptor dikes at locations shown on the plans in accordance with applicable details and specifications.

2. Unless otherwise indicated, maintain a minimum dike height of 18 inches measured from the ground at the upslope toe to the top of the dike.

3. Flow from dikes shall be diverted to sediment trapping devices of the types and at locations shown on the plans. The grades for dikes shall provide positive drainage to the outlet.

F. ROCK FILTER DAMS

1. Trees, brush, stumps, and other objectionable material shall be removed and disposed of as necessary so as not to interfere with the construction of the filter dams.

2. The filter dams shall be constructed according to the following criteria unless otherwise shown on the plans:
a. Type 1 (non-reinforced)
   Height  18 inches minimum measured vertically from existing ground to top of filter dam.
   Top Width  2 feet minimum
   Slopes  2:1 maximum.

b. Type 2 (reinforced).
   Height  18 inches minimum measured vertically from existing ground to top of filter dam.
   Top Width  2 feet minimum
   Slopes  2:1 maximum.

   The aggregate shall be placed on the galvanized wire mesh to the lines, height, and slopes specified without resulting in undue voids and to the satisfaction of the Engineer. The mesh shall be folded at the upstream side over the aggregate and secured to itself on the downstream side. The mesh shall be attached to itself with wire ties, hog rings, or as directed by the Engineer.

c. Type 3 (reinforced).
   Height  36 inches minimum measured vertically from existing ground to top of filter dam.
   Top Width  2 feet minimum
   Slopes  2:1 maximum.

   The aggregate shall be placed on the galvanized wire mesh to the lines, height, and slopes specified without resulting in undue voids and to the satisfaction of the Engineer. The mesh shall be folded at the upstream side over the aggregate and secured to itself on the downstream side. The mesh shall be attached to itself with wire ties, hog rings, or as directed by the Engineer.

3. The area upstream from the filter dams shall be maintained in a condition which will allow sediment to be removed following the runoff of a rainfall event. When the silt reaches a depth equal to 1/3 the height of the dam or one foot, whichever is less, the Contractor shall remove the accumulated sediment and dispose of it at an approved site in a manner that will not contribute to additional sedimentation. The filter dams shall be reshaped as needed and as directed by the Engineer.
4. The filter dams shall be maintained in place until all upstream areas are adequately stabilized. The area beneath the filter dams and area damaged by the removal process shall then be stabilized by the Contractor using appropriate methods as approved by the Engineer.

G. STABILIZED CONSTRUCTION EXIT

1. The Contractor shall provide stabilized construction exits at the locations shown on the plans and as necessary to prevent vehicles leaving the site from tracking sediment off-site.

2. Stabilized construction exits shall be a minimum of 50 feet long, 14 feet wide, and eight inches thick. The Contractor shall enlarge stabilized construction exits at his own expense if necessary to prevent off-site tracking of sediment.

3. The Contractor shall periodically add rock as necessary for the stabilized construction exit to continue to function as intended.

4. The stabilized construction exit and the surrounding area shall be graded as necessary to route runoff from these areas to other erosion and sedimentation controls.

H. PROTECTION OF BARE AREAS

1. Apply seeding and soil retention blanket to bare areas including new embankment areas, fills, stripped areas, graded areas, or otherwise disturbed areas which have a grade greater than five percent or which will be exposed for more than 30 days. Blankets shall be in accordance with section 02370 – Erosion Control Fabric.

2. Bare working areas on which it is not practical or desirable to install seeding and soil retention blankets, as determined by the Engineer, such as areas under proposed building slabs, shall be temporarily sloped to drain at a minimum of 0.2 percent and a maximum of five percent. These areas shall then be "trackwalked" with a crawler dozer traveling up and down the slope to form the effect of small "terraces" with the tracks of the dozer. Cover each area a minimum of three times.

3. Route runoff from the areas through the appropriate erosion and sediment control structures.

4. Protect earth spoil areas by "trackwalking" and silt fences.
5. When topsoil is called for as a component of another item, conduct erosion control practices described in this item during the topsoiling operation.

   a. When topsoiling, maintain erosion and sediment control structures such as swales, grade stabilization structures, berms, dikes, waterways, and sediment basins.

   b. Maintain grades that have been previously established on areas to be topsoiled.

   c. After the areas to be topsoiled have been brought to grade, and immediately prior to dumping and spreading the topsoil, the subgrade shall be loosened by disking or by scarifying to a depth of at least two inches to permit bonding of the topsoil to the subsoil. Compact soil by passing a bulldozer up and down the slope, tracking over the entire surface area of the slope to create small “terraces”.

6. Dust Control

   a. Control dust blowing and movement on construction sites and roads to prevent exposure of soil surfaces, to reduce on-site and off-site damage, to prevent health hazards, and to improve traffic safety.

   b. Control dust blowing by utilizing one or more of the following methods.

      1) Establishment of temporary vegetative cover

      2) Tillage to roughen surface and bring clods to the surface

      3) Irrigation by water sprinkling

      4) Utilization of barriers such as solid board fences, snow fences, burlap fences, crate walls, bales of hay, or similar materials.

   c. Dust control methods shall be implemented immediately whenever dust is observed blowing over the project site.

I. LOCATION OF EROSION AND SEDIMENT CONTROL STRUCTURES

   1. Locate erosion and sediment control structures as shown on the plans and as required to prevent erosion and removal of sediment from the project site. Silt fences shall be required for disturbed areas and soil stockpiles/spoil areas. The runoff from no more than one acre of area shall be routed through any individual silt fence installation.

   2. Install diversion dikes to divert runoff to other erosion and sediment control structures.
3. Install silt traps at the inlet (upstream) end of drainage structures, including open channels, through which runoff from disturbed areas or soil stockpiles/spoil areas may drain.

4. Provide an overall erosion and sediment control system which protects disturbed areas and soil stockpiles/spoil areas. The system shall be modified by the Contractor as needed to effectively control erosion and sediment during construction.

3.2 MAINTENANCE

A. Maintain erosion and sediment control structures and procedures in full working order at all times during construction. This shall include any necessary repair or replacement of items which have become damaged or ineffective. Remove sediment on a regular basis which accumulates in sediment control devices and place the material in approved earth spoil areas, return the material to the area from which it eroded, or dispose of it off-site.

B. The Contractor shall prohibit all equipment and vehicles from maneuvering in areas outside the dedicated rights-of-way and easements for construction. Damage caused by construction traffic to erosion and sedimentation control systems shall be repaired immediately at the expense of the Contractor.

C. Upon completion of construction and stabilization of disturbed areas, properly remove the temporary erosion and sediment control structures and complete the area as indicated.

D. Soil retention blankets will not require removal if installed on a finished graded area specified to receive seeding.

3.3 FIELD QUALITY CONTROL

In the event of conflict between these requirements and storm water pollution control laws, rules, or regulations of federal, state, or local agencies, the more restrictive requirements shall apply.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES

A. Removal of surface debris.

B. Removal of trees, shrubs, and other plant life.

1.2 REGULATORY REQUIREMENTS

A. Conform to applicable code for environmental requirements, disposal of debris, burning debris on site, and use of herbicides.

B. Coordinate clearing Work with utility companies.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 PREPARATION

A. Verify that existing plant life designated to remain is tagged or identified.

B. Identify an area for placing removed materials.

3.2 PROTECTION

A. Locate, identify, and protect utilities that remain, from damage.

B. Protect trees, plant growth, and features designated to remain, as final landscaping.

C. Protect bench marks, survey control points, and existing structures from damage or displacement.

3.3 CLEARING

A. Clear areas required for access to site and execution of Work.

B. Remove trees and shrubs within marked areas. Remove stumps, main root ball, root system to a depth of 24 inches.
DUNDEE STATE FISH HATCHERY OZONE SYSTEM
PROJECT NUMBER 128632

C. Clear undergrowth and deadwood.

3.4 REMOVAL

A. Remove debris, rock, and extracted plant life from site.

B. Partially remove paving, and curbs as indicated. Neatly saw cut edges at right angle to surface.

3.5 TOPSOIL EXCAVATION

A. Excavate topsoil from areas to be further excavated, re-landscaped, or re-graded, without mixing with foreign materials.

B. Do not excavate wet topsoil.

C. Stockpile in area designated on site to depth not exceeding 8 feet and protect from erosion.

D. Remove excess topsoil not intended for reuse, from site.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES
A. Subsoil materials.
B. Topsoil materials.

1.2 RELATED SECTIONS
A. UGC Article 8 – Quality Control
B. Section 02207 – Aggregate Materials.
C. Section 02225 – Excavating, Backfilling, and Compacting for Utilities.

1.3 REFERENCES
B. ASTM D2487 – Classification of Soils for Engineering Purposes.
C. ASTM D2922 – Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
D. ASTM D3017 – Test Method for Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

1.4 SUBMITTALS FOR REVIEW
A. UGC Article 8 – Quality Control; Submittals
B. Samples: Submit, in air-tight containers, 10 lb. sample of each type of fill to testing laboratory. All off-site materials must be approved by the Engineer prior to installation.

1.5 SUBMITTALS FOR INFORMATION
A. UGC Article 8 – Quality Control; Submittals: Procedures for submittals.
B. Materials Source: Submit name of imported materials source.

1.6 QUALITY ASSURANCE
A. Perform Work in accordance with plans and specifications, TxDOT standards, and Owner requirements.
PART 2 PRODUCTS

2.1 SOIL MATERIALS

A. Soil Type S1 – Subgrade material:
   1. Material remaining in place after excavation.
   2. Suitable for slab/foundation subgrade, undisturbed nor over excavated.
   3. Where subgrade soils are soft, loose, or otherwise unsatisfactory, the soil shall be removed and replaced with select fill or soil cement as determined by the Engineer.

B. Soil Type S2 – Common Fill:
   1. Due to the proximity of the lake, excavated and re-used material may not likely meet requirements. Imported borrow material from borrow area approved by the Engineer.
   2. Graded free of lumps larger than 3 inches, rocks larger than 2 inches, excessive silts and debris.
   3. Do not use soil containing brush, roots, or similar organic matter.
   4. Conforming to ASTM D2487 Class III soils with a liquid limit less than 40, and a plasticity index less than 20, but greater than 4.

C. Soil Type S3 – Select Fill:
   1. Imported borrow material from borrow area approved by the Engineer. Material shall be tested for compliance by the Contractor and test results submitted to the Engineer for approval. Select Fill material is not available on site.
   2. Clayey sand soils free from organic matter with no lumps larger than 1 inch, no rocks larger than ½ inch, nor excessive silts.
   3. Do not use soils containing brush, roots, sod or other organic materials.
   4. Select fill shall conform to ASTM D2487 Class II or Class III and shall have a liquid limit less than 30 with a plasticity index less than 15 but greater than 4.

D. Soil Type S4 – Top Soil:
   1. Soil suitable for growth of surface cover. Material stripped and stockpiled from site or borrowed from off site.
   2. Free from roots, brush, rocks, and other extraneous matter exceeding 1 inch in any direction. Free from weeds
3. Minimum 60% sand, Maximum 30% silts, Maximum 10% clay, no less than 6% and no more than 20% organic matter.

4. Submit test data showing compliance with this specification. Include percent weight of constituent material, material particle size, and pH.

2.2 SOURCE QUALITY CONTROL

A. UGC Article 8 – Quality Control: Testing and analysis of soil material.

B. Testing and Analysis of Subsoil Material: Perform in accordance with ASTM D698.

C. Testing and Analysis of Topsoil Material: Perform in accordance with ASTM D698.

D. If tests indicate materials do not meet specified requirements, change material and retest.

E. Provide materials of each type from same source throughout the Work. A change in source requires sampling, testing, and approval by the Engineer.

PART 3 EXECUTION

3.1 SOIL REMOVAL

A. Excavate soils from areas designated.

B. Remove lumped soil, boulders, and rock.

C. Stockpile excavated material in area designated on site and remove excess material not being used, from site.

3.2 STOCKPILING

A. Stockpile materials on site at locations designated by Engineer.

B. Stockpile in sufficient quantities to meet Project schedule and requirements.

C. Separate differing materials with dividers or stockpile apart to prevent mixing.

D. Prevent intermixing of soil types or contamination.

E. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.

3.3 STOCKPILE CLEANUP

A. Excess material in stockpile shall be removed and disposed of at the end of the project.

B. Remove stockpile, leave area in a clean and neat condition. Grade site surface to prevent free standing surface water.
C. If a borrow area is indicated, leave area in a clean and neat condition. Grade site surface to prevent free standing surface water.

END OF SECTION
DUNDEE STATE FISH HATCHERY OZONE SYSTEM
PROJECT NUMBER 128632

SECTION 02207

AGGREGATE MATERIALS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Aggregate materials.

1.2 RELATED SECTIONS

A. UGC Article 8 - Quality Control.
B. Section 02205 - Soil Materials.
C. Section 02225 – Excavation, Backfilling, and Compacting for Utilities.

1.3 REFERENCES

C. ASTM D2487 - Classification of Soils for Engineering Purposes.
D. ASTM D2922 - Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
E. ASTM D3017 - Test Method for Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

1.4 SUBMITTALS FOR REVIEW

A. Product data sheet on all aggregates and riprap to be used in the project
B. Submit, in air-tight containers, 10 lb. sample of each type of material to testing laboratory. Materials must be approved by the Engineer prior to installation.

1.5 QUALITY ASSURANCE
A. Perform Work in accordance with TxDOT specifications and the requirements of the drawings.

PART 2 PRODUCTS

2.1 COARSE AGGREGATE MATERIALS

A. Aggregate Type A1 - Drain Rock

1. Drain rock shall be clean, washed, sound, durable, well-graded crushed rock, crushed gravel, or natural stone gravel.

2. Drain rock shall conform to ASTM C33 Size No. 3 coarse aggregate as shown in the following table.

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing (By Weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 ½ in.</td>
<td>100</td>
</tr>
<tr>
<td>2 in.</td>
<td>90-100</td>
</tr>
<tr>
<td>1 ½ in.</td>
<td>35-70</td>
</tr>
<tr>
<td>1 in.</td>
<td>0-15</td>
</tr>
<tr>
<td>½ in.</td>
<td>0-5</td>
</tr>
</tbody>
</table>

B. Aggregate Type A2 – Type 1 Pipe Embedment

1. Type 1 pipe embedment shall be clean, washed, sound, durable, well-graded crushed rock, crushed gravel, or natural stone gravel. Type 1 shall conform to the Class 1 ASTM D2487 class of embedment / backfill materials.

2. Type 1 pipe embedment shall conform to ASTM C33 Size No. 57 coarse aggregate as shown in the following table.

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing (By Weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ½ in.</td>
<td>100</td>
</tr>
<tr>
<td>1 in.</td>
<td>95-100</td>
</tr>
<tr>
<td>½ in.</td>
<td>25-60</td>
</tr>
<tr>
<td>No. 4</td>
<td>0-10</td>
</tr>
<tr>
<td>No. 8</td>
<td>0-5</td>
</tr>
</tbody>
</table>

C. Aggregate Type A3 – Type 2 Pipe Embedment

1. Type 2 pipe embedment shall consist of a well-graded, angular, crushed rock with a maximum particle size of 1.5 inch. No more than 10% of the material shall pass the No. 200 sieve. Type 2 shall conform to the Class II ASTM D2487 class of embedment / backfill materials.
D. Aggregate Type A4 - Pea Gravel
   1. Pea gravel shall be natural gravel that is washed and free of clay, shale, and organic matter. It shall be graded in accordance with ASTM C136 to the following limits:
      2. Minimum Size: 1/4 inch
      3. Maximum Size: 5/8 inch

E. Aggregate Type A5 – Type “R” Modified Rock Riprap:
   1. Natural stone, washed free of clay and shale, and shall meet all of the requirements of TxDOT Item 432, for Type R Stone Riprap with the following modifications:
      a. Stones shall weight between 50 to 150 pounds with no less than 50 percent of the stones shall weigh more than 100 pounds.
      b. Rock’s longest dimension shall not exceed 3 times that of the shortest dimension.
      c. Delete paragraphs 432.5 Measurement and 432.6 Payment, and refer to Section 01200 – Unit Bid Prices of these specifications.

F. Aggregate Type A7 – Flexible Base
   1. Flexible base material shall be crushed stone produced from oversize quarried aggregate, sized by crushing, and produced from a naturally occurring single source. Crushed gravel or uncrushed gravel shall not be acceptable. No blending of sources or additive materials will be allowed in flexible base.
   2. Flexible base material shall conform to TxDOT Item No. 247 Type A Grade 2.

2.2 FINE AGGREGATE MATERIALS

Aggregate Type A6 – Sand

A. Sand shall be natural river or bank sand that is free of silt, clay, loam, friable or soluble materials, and organic matter. Type A6 shall conform to the Class III ASTM D2487 (for sands) class of embedment / backfill materials.
B. Sand shall conform to the gradation shown in the following table.

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing (By Weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 4</td>
<td>100</td>
</tr>
<tr>
<td>No. 16</td>
<td>80-100</td>
</tr>
<tr>
<td>No. 50</td>
<td>20-60</td>
</tr>
<tr>
<td>No. 100</td>
<td>10-40</td>
</tr>
<tr>
<td>No. 200</td>
<td>0-10</td>
</tr>
</tbody>
</table>

2.3 SOURCE QUALITY CONTROL

A. UGC Article 8 - Quality Control.


C. Provide materials of each type from same source throughout the Work. A change in source requires sampling, testing, and approval by the Engineer.

PART 3 EXECUTION

3.1 STOCKPILING

A. Stockpile materials on site at locations designated by the Engineer.

B. Stockpile in sufficient quantities to meet Project schedule and requirements.

C. Separate differing materials with dividers or stockpile apart to prevent mixing.

D. Direct surface water away from stockpile site so as to prevent erosion or deterioration of materials.

3.2 STOCKPILE CLEANUP

A. Excess material in stockpile shall be removed and disposed of at the end of the project.

B. Remove stockpile, leave area in a clean and neat condition. Grade site surface to prevent free standing surface water.
C. If a borrow area is indicated, leave area in a clean and neat condition. Grade site surface to prevent free standing surface water.

3.3 INSTALLATION

A. Install all aggregate materials to the lines, grades, depth, and dimensions as shown on the plans.

B. Aggregate shall be compacted as required by the plans and tested in accordance with ASTM D698.

C. Aggregate materials installed beyond the dimensions shown on the drawings shall not result in additional pay to the Contractor.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES:

A. Requirements for Trench and Excavation Safety System(s) to be designed and furnished by the Contractor for the safety and health of personnel.

1.2 REFERENCES:


B. Others - Other applicable Federal, State, and local rules for Trench Construction or excavations. See the Texas Parks and Wildlife UGC Section 7.6

1.3 REQUIREMENTS:

A. See the Texas Parks and Wildlife UGC Article 7 – Construction Safety. The Contractor shall bear the sole responsibility for the adequacy of the System.

B. The requirements of 29CFR1926 shall be the minimum requirements for this specification and are adopted as a part of this specification. Other regulations relating to trench and excavation safety shall also be considered a part of this specification as if referenced directly.

C. Should the System require wider trenches than shown, the Contractor shall be responsible for the costs associated with determining adequacy of pipe bedding and class, as well as, purchase and installation of alternate and/or additional materials.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 GENERAL:

A. Implement the system in accordance with the written System Plan and conduct affected work in accordance with the same.

B. The system shall be in use during all phases of construction.
C. Neither the Engineer nor the Owner will be responsible for ensuring the trench safety system is constructed and utilized in accordance with the safety plan. This shall be the sole responsibility of the contractor.

PART 4 MEASUREMENT & PAYMENT

4.1 MEASUREMENT:

A. Trench safety shall be measured on a linear foot basis. No evaluation of the adequacy of the trench safety precautions will be made by the Engineer since the means, methods & responsibility for safety rest solely with the Contractor.

4.2 PAYMENT

A. See the Texas Parks and Wildlife UGC Article 10 – Payments. The Contractor shall bear the sole responsibility for the adequacy of the System. Approving the Contractor’s request for payment of trench safety, the Engineer makes no representation that the Contractor’s work for this pay item has been performed in a manner consistent with the Contract documents.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES:

A. Excavation shall include removal of all earth, rock, or other materials to the extent necessary to install structures and appurtenances in conformance with the lines and grades shown in the plans, or as specified.

B. Backfilling and compacting shall include all backfilling, embankment, and compaction necessary to install structures and appurtenances in conformance with the lines and grades shown in the plans, or as specified.

1.2 RELATED SECTIONS:

A. Section 02205 – Soil Materials

B. Section 02207 – Aggregate Materials

C. Section 02220 – Trench and Excavation Safety System

1.3 REFERENCES:

A. ASTM C33 - Coarse Aggregates.

B. ASTM D698 - Standard Methods of Test for Moisture-Density Relations of Soil (Standard).

C. ASTM D1557 - Test for Moisture-Density Relations of Soil (Modified).

D. ASTM D2487 - Classification of Soils for Engineering Purposes.

E. ASTM D2922 - Density of Soil and Soil Aggregate In-Place by Nuclear Methods.

F. ASTM D3017 - Moisture Content of Soil and Soil Aggregate In-Place by Nuclear Methods.

G. ASTM D4254 - Minimum Index Density and Unit Weight of Soils and Calculations of Relative Density.

H. ASTM D4318 - Test for Liquid Limit, Plastic Limit and Plasticity Index of Soils.

I. OSHA - Occupational Safety and Health Administration and Related Regulations.

1.4 SUBMITTALS:

A. Procedures for Submittals: UGC Article 8 – Quality Control; Submittals.
B. Samples: Aggregate samples of material as required by the testing laboratory.

C. Quality Control Submittals: For information only.

1.5 PROTECTION OR REMOVAL OF UTILITY LINES:

A. The Contractor shall anticipate all underground obstructions such as, but not limited to, water mains, gas lines, storm and sanitary sewers, telephone or electric light or power ducts, concrete, and debris.

1. It shall be the responsibility of the Contractor to verify the existence and location of all underground utilities along the route of the work.

2. Any such lines or obstructions indicated on the Drawings show only the approximate locations and shall be verified in the field by the Contractor.

3. The Owner and Engineer will endeavor to familiarize the Contractor with all known utilities and obstructions, but this shall not relieve the Contractor from full responsibility in anticipating all underground obstructions whether or not shown on the Drawings.

4. The omission from or the inclusion of utility locations on the plans is not to be considered as the non-existence of, or a definite location of existing underground utilities.

B. The Contractor shall, at his own expense, maintain in proper working order and without interruption of service all existing utilities and services which may be encountered in the work.

1. With the consent of the Engineer and utility owner such service connections may be temporarily interrupted to permit the Contractor to remove designated lines or to make temporary changes in the locations of services.

2. The cost of making any temporary changes shall be at the Contractor's expense.

C. The Contractor will take the necessary precautions to protect existing utilities from damage due to his operations.

D. Any damage to the utilities will be repaired at the Contractor's expense.

E. Notify all utility companies involved to have their utilities located and marked in the field.

1. All underground utilities shall then be uncovered to verify location and elevation before construction begins.

2. The Contractor shall obtain all necessary permits.

F. The Contractor shall obtain necessary permits, except right-of-way permits, required for completion of the project.
G. Utility Spacing: The spacing for utility lines shall meet the installation requirements and the requirements of the TCEQ.

1.6 PROJECT CONDITIONS:

A. Maximum and Minimum Width of Excavation:

1. Unless otherwise specified on the plans, the minimum width of trench in which the pipe may be installed shall be 12 inches plus the outside diameter of the pipe or the structure.

2. The maximum width shall be 24 inches plus the outside diameter of the pipe or the structure.

3. Whenever the prescribed maximum trench width is exceeded, except as such excess may be necessary for compliance with the plans or specifications, the pipe may be cradled with Class 2500 Concrete as directed by the Engineer, and at the expense of the Contractor.

B. Protection:

1. Erect sheeting, shoring, and bracing as necessary for protection of persons, improvements, existing structures, and excavations.

2. See Section 02220 for requirements for sheeting, shoring, and bracing for trench and excavation safety.

C. Dewatering of Trenches and Excavations

1. This section covers the dewatering of trenches to the extent that bedding material and pipe can be placed on dry, firm trench bottom.

2. Provide dewatering and drainage necessary to keep excavations free of water.

   a. Dewatering System shall maintain the water level a minimum of 3 feet below the excavation.

   b. Contractor shall provide and maintain all dewatering equipment during excavation, construction, backfill, and until structure is placed in service.

   c. Contractor shall operate dewatering system continuously without interruption during weekends and/or holidays.

3. Dewatering of trenches other than by wellpointing shall be accomplished by whatever means elected by the contractor; however, bedding material or pipe may not be placed in wet or unstable trenches.
4. Soil that cannot be properly dewatered shall be excavated and Coarse Aggregate Type A3-1 material placed to such a depth as may be required to provide a firm trench bottom.

5. Surface Runoff:
   a. Surface runoff water shall be diverted away from the trenches.
   b. Such diversion shall be into existing drainage structures, such as storm sewers, ditches, or streams.
   c. Diversion of surface runoff shall be in such a manner to prevent flooding of streets or private property.

6. Disposal of Water from Dewatering:
   a. All water removed from the trenches by wellpointing or any other means shall be pumped, piped, or drained into existing drainage structures, such as storm sewers, ditches, or streams.
   b. The disposal of water from dewatering operations shall be accomplished in a manner that will prevent the flooding of public or private property.
   c. Provisions shall be made for the satisfactory disposal of surface water pumped so as to prevent damage to public or private property.

D. Coordination: Coordinate backfill operations with installation of utilities.

PART 2 PRODUCTS

2.1 MATERIALS

A. General Site Fill: Section 02205.2.1.B – Soil Type S2 – Common Fill
B. Earth Backfill: Section 02205.2.1.C – Soil Type S3 – Select Fill
C. Topsoil: Section 02205.2.1.D – Soil Type S4 – Top Soil
D. Aggregate: Section 02207.2.1.B – Coarse Aggregate Type A2 – Pipe Embedment
E. Crushed Rock: Section 02207.2.1.D – Coarse Aggregate Type A3-1 – Foundation Material for Unsuitable Subgrade
F. Sand: Section 02207.2.2.A – Fine Aggregate Type A5 - Sand

PART 3 EXECUTION

3.1 EXAMINATION AND PREPARATION:
DUNDEE STATE FISH HATCHERY OZONE SYSTEM
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A. Examine project site and investigate existing subsurface conditions to determine nature, kind and character of materials and conditions to be encountered.

B. Prior to commencing excavation operations, disconnect and cap or protect existing utility services, if any, in accordance with the requirements of the owning companies and applicable ordinances and regulations.

C. Provide for surface drainage.

D. Keep excavations free of water during entire progress of the work.

E. Prior to backfilling grade beams and below grade walls, verify that beams, walls and footing have properly cured.

F. Verify that forms, trash, debris and applicable temporary shoring have been removed.

G. Verify that walls are supported at top and bottom.

3.2 EXCAVATION AND SUBGRADE PREPARATION – STRUCTURES:

A. Excavate beneath structures to lines, grades, and elevations as shown.
   1. Over excavation shall be restored by the Contractor at his own expense.
   2. Over excavation shall be corrected by backfilling with select fill in 8-inch lifts.
   3. Compact to 95% of maximum density within 2% of optimum moisture per ASTM D698.

B. Scarify exposed surfaces to a depth of 8 inches and recompact to a density of 95 percent of the maximum density when tested by the Standard Proctor Compaction Test (ASTM D698), at a moisture content of ±2 percent of optimum.

C. Remove weak or highly organic soils noted by probing and replace with general site fill. Place fill in 8-inch lifts and compact to 95 percent of maximum density (ASTM D698) at a moisture content of ±2 percent of optimum.

D. Do not extend structure fill beyond structure lines or as shown.

E. Excavation is unclassified.
   1. Break rock with hydraulic ram to obtain near neat line excavation.
   2. Blasting is not allowed.

3.3 BACKFILL – STRUCTURES:

A. Schedule backfilling to expedite construction progress.
DUNDEE STATE FISH HATCHERY OZONE SYSTEM
PROJECT NUMBER 128632

B. Backfill in manner to prevent excessive pressure against previously completed work and to prevent damage or displacement to utility systems.

C. Backfill structure walls with select fill.
   1. Compact by vibrating to 95 percent of maximum density within two percent of optimum moisture as measured by ASTM D698.
   2. Do not over compact. Place backfill in 8-inch lifts.

D. Exercise care to prevent over compaction of backfills.

E. Where top of below grade structure backfill is not covered with paving or other impervious barrier, the final 2 feet of backfill shall be select fill.
   1. Place fill in 8 inch thick lifts and compact to 95 percent of maximum density at ±2 percent of optimum moisture content.
   2. Allow for 4 inches of topsoil placement.

3.4 MATERIAL DISPOSAL:

A. Suitable excavated materials shall be piled adjacent to the work to be used for backfilling.

B. Excavated materials unsuitable for the backfilling, or in excess of that required for backfilling shall be disposed of by the Contractor at locations designated on the plans or approved by the Engineer.

C. Desirable topsoil, sod, etc. shall be carefully piled separately in its original position when required.

D. Excavated materials shall be handled at all times in such a manner as to cause a minimum inconvenience to public travel and to permit safe and convenient access to private and public property adjacent to or along the line of the work.

E. In parkways and easements where it is necessary to deposit excavated materials on lawns during the work, burlap or similar materials shall be placed on the lawn to prevent contact between excavated materials and the lawn.

F. Remove waste and excess excavated material from the construction site before final inspection.

G. Legally dispose of material at a licensed site or with written and notarized permission from the property owner for a private disposal site.

H. All costs associated with waste material removal and disposal shall be paid for by the Contractor.
DUNDEE STATE FISH HATCHERY OZONE SYSTEM
PROJECT NUMBER 128632

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES:

A. Excavating, trenching, backfilling and compacting for water distribution mains, force mains, gravity sanitary sewers, manholes and other utility systems and appurtenances, and the disposal of excess excavated material.

1.2 RELATED SECTIONS:

A. Section 02205 – Soil Materials
B. Section 02207 – Aggregate Materials
C. Section 02220 – Trench and Excavation Safety System

1.3 REFERENCES:

A. ASTM C33 - Coarse Aggregates.
B. ASTM D698 - Standard Methods of Test for Moisture-Density Relations of Soil (Standard).
C. ASTM D1557 - Test for Moisture-Density Relations of Soil (Modified).
D. ASTM D2487 - Classification of Soils for Engineering Purposes.
E. ASTM D2922 - Density of Soil and Soil Aggregate In-Place by Nuclear Methods.
F. ASTM D3017 - Moisture Content of Soil and Soil Aggregate In-Place by Nuclear Methods.
G. ASTM D4254 - Minimum Index Density and Unit Weight of Soils and Calculations of Relative Density.
H. ASTM D4318 - Test for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
I. OSHA - Occupational Safety and Health Administration and Related Regulations.

1.4 SUBMITTALS:

A. Procedures for Submittals: UGC Article 8 – Quality Control; Submittals.
B. Samples: Aggregate samples of material as required by the testing laboratory.
C. Quality Control Submittals: For information only.

1.5 PROTECTION OR REMOVAL OF UTILITY LINES:
A. The Contractor shall anticipate all underground obstructions such as, but not limited to, water mains, gas lines, storm and sanitary sewers, telephone or electric light or power ducts, concrete, and debris.

1. Any such lines or obstructions indicated on the Drawings show only the approximate locations and shall be verified in the field by the Contractor.

2. The Owner and Engineer will endeavor to familiarize the Contractor with all known utilities and obstructions, but this shall not relieve the Contractor from full responsibility in anticipating all underground obstructions whether or not shown on the Drawings.

B. The Contractor shall, at his own expense, maintain in proper working order and without interruption of service all existing utilities and services which may be encountered in the work.

1. With the consent of the Engineer and utility owner such service connections may be temporarily interrupted to permit the Contractor to remove designated lines or to make temporary changes in the locations of services.

2. The cost of making any temporary changes shall be at the Contractor's expense.

C. Notify all utility companies involved to have their utilities located and marked in the field.

1. All underground utilities shall then be uncovered to verify location and elevation before construction begins.

2. The Contractor shall obtain all necessary permits.

D. The Contractor shall obtain necessary permits, except right-of-way permits, required for completion of the project.

E. Utility Spacing: The spacing for utility lines shall meet the installation requirements and the requirements of the TCEQ.

1.6 PROJECT CONDITIONS:

A. Protection:

1. Erect sheeting, shoring and bracing as necessary for protection of persons, improvements, existing structures, and excavations.

2. Provide dewatering and drainage necessary to keep excavations free of water.
   a. Dewatering System shall maintain the water level a minimum of 3 feet below the excavation.
   b. Contractor shall provide and maintain all dewatering equipment during excavation, construction, backfill, and until utility is placed in service.
c. Contractor shall operate dewatering system continuously without interruption during weekends and/or holidays.

PART 2 PRODUCTS

2.1 MATERIALS:

A. General Site Fill: Section 02205.2.1.B – Soil Type S2 – Common Fill

B. Earth Backfill: Section 02205.2.1.C – Soil Type S3 – Select Fill

C. Topsoil: Section 02205.2.1.D – Soil Type S4 – Top Soil

D. Aggregate: Section 02207.2.1.B – Coarse Aggregate Type A2 – Pipe Embedment

E. Crushed Rock: Section 02207.2.1.D – Coarse Aggregate Type A3-1 – Foundation Material for Unsuitable Subgrade

F. Sand: Section 02207.2.2.A – Fine Aggregate Type A5 - Sand

PART 3 EXECUTION

3.1 EXAMINATION AND PREPARATION:

A. Examine utility routes and coordinate excavation work to eliminate installation conflicts.

B. Allow room for stockpiling excavated material and utility construction material during utility construction.

3.2 TRENCH EXCAVATION:

A. Procedure: Excavated to indicated or specified depths.

1. Excavate by open cut method.

2. Dispose of unacceptable backfill material and provide suitable material for backfill without additional expense.

3. During excavation, stockpile material suitable for backfilling in an orderly manner far enough from the bank of the trench to avoid overloading, slides, or cave-ins.

4. Grade as necessary to prevent surface water from flowing into trenches or other excavations.

5. Cut banks of trench as nearly vertical as practical.

   a. Remove stones as necessary to avoid point-bearing.

   b. Over-excavate wet or unstable soil from the trench bottom to permit construction of a more stable bed for pipe.
EXCAVATION, BACKFILLING, AND COMPACTING FOR UTILITIES

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c. Over excavation shall be filled and tamped with clean dry sand or other approved material to the required grade.

6. Excavate the trench the proper width as shown.
   a. If the trench width below the top of pipe is wider than specified in this Section or shown, install additional backfill.
   b. No additional payment will be made for additional material or work required for installation.

7. Accurately grade the trench bottom to provide proper bedding as required for pipe installation.

8. If any excavation is carried beyond the lines and grades required or authorized, the Contractor shall, at his own expense, fill such space with concrete or other suitable material as directed by the Engineer. No additional payment will be made.

B. Sheeting and Bracing: Install sheeting and bracing necessary to support the sides of trenches and other excavations with vertical sides, as required by current OSHA regulations.

C. Water In Excavation:
   1. Keep work free from ground or surface water at all times.
   2. Provide pumps of adequate capacity or other approved method to remove water from the excavation in such a manner that it will not interfere with the progress of the work or the proper placing of other work.

D. Trenching Progress: Trenching operations shall not be in excess of 100 feet ahead of pipe laying operations in city streets or 2,000 feet in open country.

E. Existing Lawns and Shrubbery:
   1. The Contractor shall take particular care to preserve existing lawns and shrubbery.
   2. Make minor pipe alignment changes as may be necessary with approval from the Engineer.

F. Existing Pavement:
   1. Existing pavement over trenches shall be removed to a width of 6 inches outside of the trench on each side.
   2. Remove to a neat line by sawing method. No additional payment shall be made for saw-cutting.

3.3 Pipe Bedding:
A. Pipe Zone: The pipe zone is defined as including the pipe bedding, backfill to one-half the pipe diameter (the springline) and the initial backfill to 12 inches above the top of the pipe.

B. Bedding:

1. Sheeting and shoring will not be allowed in the pipe zone during or after installation of the pipe or embedment material, unless special provisions are made to ensure the specified compaction of bedding and pipe alignment is maintained after removal of sheeting and shoring.

2. Accurately grade the bottom of the trench four (4) inches below the bottom of the pipe and to the limits of the clear space on either side of the pipe.

3. Place a minimum of four (4) inches of compacted Aggregate Material (Type A3) below the pipe and to the spring line of the pipe. Compact to 90% standard proctor.

4. The initial layer of embedment material placed to receive the pipe shall be brought up to a grade slightly higher than that required for the bottom of the pipe and the pipe shall be placed.

5. Adjustment to the grade line shall be made by tamping, scraping away, the removal of the slight excess amount of embedment material, or filling with embedment materials. Wedging or blocking up of pipe will not be permitted.

6. Each pipe section shall have a uniform bearing on the embedment for the full length of the pipe, except immediately at the joint.

7. After each pipe has been graded, aligned, placed in final position on the bedding material and joint made, sufficient embedment material shall be deposited and compacted under and around each side of the pipe and back of the bell or end thereof to hold the pipe in proper position and alignment during subsequent pipe jointing and embedment operations.

8. Additional Aggregate Material (Type A3) shall be deposited simultaneously on each side of pipe and compacted uniformly to the spring line.

9. Place Aggregate Material (Type A3) shall be deposited simultaneously on each side of pipe and compacted uniformly to the a depth of six (6) inches above the top of the pipe. Compact to 90% standard proctor.

10. After the pipe and embedment have been placed, complete the backfilling of the pipe trenches to the proposed finished grade elevation by the following method:

   a. Selected material, meeting the requirements for Type S2 Backfill, shall be placed on both sides of the pipe simultaneously in layers of not more that six (6) inches in loose thickness, and the layer shall be firmly compacted by had or mechanical tamping to the limits specified below.
b. The layers of backfill shall be sprinkled lightly with water if additional moisture is required for proper compaction.

c. This process of filling and tamping in layers shall be continued until the backfill is brought up to 18 inches above the top of the pipe.

d. Rolling compaction devices may be used to complete that backfill as required once the pipe has a minimum of 18 inches of compacted backfill placed over the top of the pipe.

11. Compact the bedding and backfill to a minimum of 90 percent of maximum dry density per ASTM D698, maintaining moisture within ±2 percent of optimum or 70 percent of relative density per ASTM D4254.

C. Water Supply and Distribution Lines:

1. Provide a minimum cover over the top of the pipe as indicated.

2. Avoid interference of water lines with other utilities.

3. Provide class of bedding as shown.

4. Install piping and appurtenances as specified.

3.4 BACKFILLING:

A. Criteria:

1. Backfill trenches to ground surface with material as specified.

2. Reopen trenches improperly backfilled to depth required for proper compaction.

3. Refill and compact as specified, or otherwise correct the condition in an approved manner.

B. Open Areas:

1. Above the pipe zone, deposit earth backfill in 8-inch lifts.

2. Mound excess material over trench as shown.

3. Excavated material placed shall be free of rock greater than 6 inches in any direction.

4. All forms, lumber, trash and debris shall be removed from trenches, manholes and other utility structures.

5. Backfill for manholes, utility pull boxes and other utility structures shall be placed in accordance with applicable Specification Sections.
C. Pavement Section:

1. Above pipe zone, place compacted ASTM D2487 Class II material in 6-inch lifts.

2. Compact to 95% of maximum density within 2% of optimum moisture per ASTM D698.

3. Complete the backfill with aggregate base course and asphalt paving as specified and detailed.

3.5 DISPOSAL OF EXCESS MATERIAL:

A. Excavated materials unsuitable for the backfilling, or in excess of that required for backfilling shall be disposed of by the Contractor at eligible locations as or approved by the Engineer.

B. Desirable topsoil, sod, etc. shall be carefully piled separately in its original position when required.

C. Excavated materials shall be handled at all times in such a manner as to cause a minimum inconvenience to public travel and to permit safe and convenient access to private and public property adjacent to or along the line of the work.

D. In parkways and easements where it is necessary to deposit excavated materials on lawns during the work, burlap or similar materials shall be placed on the lawn to prevent contact between excavated materials and the lawn.

E. Suitable excavated materials shall be piled adjacent to the work to be used for backfilling.

F. Remove waste and excess excavated material from the construction site before final inspection.

G. Legally dispose of material at a licensed site or with written and notarized permission from the property owner for a private disposal site.

H. All cost associated with waste material removal and disposal shall be paid for by the Contractor.

END OF SECTION
DUNDEE STATE FISH HATCHERY OZONE SYSTEM
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SECTION 02230

CLEARING AND GRUBBING

PART 1 GENERAL

1.1 SECTION INCLUDES

Labor, materials, equipment, and incidentals necessary to perform operations in connection with clearing, grubbing, and disposal of cleared and grubbed materials.

1.2 DEFINITIONS

A. CLEARING: Clearing is defined as the removal of trees, shrubs, bushes, and other organic matter at or above original ground level.

B. GRUBBING: Grubbing is defined as the removal of stumps, roots, boards, logs, and other organic matter found at or below original ground level.

PART 2 PRODUCTS

[Not Used]

PART 3 EXECUTION

3.1 PREPARATION

A. Mark areas to be cleared and grubbed prior to commencing clearing operations. Engineer shall approve clearing and grubbing limits prior to commencement of clearing operations.

B. Trees and shrubs outside of the clearing limits, which are within 10' of the clearing limits, shall be clearly marked to avoid damage during clearing and grubbing operations.

C. With the Engineer's approval, the Contractor may remove trees and brush outside the clearing limits, but within the immediate vicinity of the work, when the trees or brush interfere with or retard the progress of construction operations.

D. Clearly mark trees and shrubs within the clearing limits which are to remain and protect the trees and shrubs from damage during the clearing and grubbing operations.

E. The clearing limits shall not extend beyond the project limits.

F. Establish the clearing limits as follows:
DUNDEE STATE FISH HATCHERY OZONE SYSTEM
PROJECT NUMBER 128632

1. Embankments plus 10' beyond the toe of the embankment.
2. Excavations plus 5' beyond the top of the excavation.
3. Concrete structures plus 10' beyond the edge of the footing.
5. 20’ feet along the centerline of the overhead utility lines.

G. Establish the grubbing limits as follows:
   1. Embankments plus 2' beyond the toe of the embankment.
   2. Concrete structures plus 2' beyond the edge of the footing.

3.2 INSTALLATION

A. CLEARING

Clearing shall consist of the felling and the satisfactory disposal of trees and other vegetation together with the down timber, snags, brush, rubbish, and debris occurring within the area to be cleared.

B. GRUBBING

   1. Grubbing shall consist of the removal and disposal of stumps and roots larger than 1" in diameter.

   2. Extend grubbing to the depth indicated below. In the case of multiple construction items, the greater depth shall apply.

      a. Footings - 18" below the bottom of the footing.
      b. Roads - 18" below the bottom of the subgrade.
      c. Embankments - 24" below existing ground.
      d. Concrete Structures - 18" below the bottom of the concrete.

3.3 FIELD QUALITY CONTROL

A. Completely remove timber, logs, roots, brush, rotten wood, and other refuse from the Owner's property.

B. Disposal of materials in streams shall not be permitted and no materials shall be piled in stream channels or in areas where it might be washed away by floods.
C. Timber within the area to be cleared shall become the property of the Contractor and the Contractor may cut, trim, hew, saw, or otherwise dress felled timber within the limits of the Owner's property provided the timber and waste material is disposed of in a satisfactory manner.

D. Materials shall be removed from the site weekly, unless permission is granted by the Engineer to store the materials for longer periods. Under no circumstances will the Contractor be allowed to bury timber and/or waste material on-site.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES
   A. Erosion control fabric

1.2 RELATED SECTIONS
   A. Section 02936 - Seeding.

1.3 SUBMITTALS FOR REVIEW
   A. Submit 8” x 8” sample if not by pre-approved supplier and product data sheets for materials to be used.

1.4 QUALITY CONTROL
   A. Pre-approved Acceptable Manufacturers
      1. American Excelsior Company, Arlington, Texas
      2. Erosion Control Systems, Inc., Tuscaloosa, Alabama

PART 2 PRODUCTS

2.1 MATERIAL
   A. Blanket: Plastic reinforced excelsior blanket shall be used for erosion control. Blanket shall be a machine produced mat of curled wood excelsior covered on one side with a photo-degradable plastic mesh. Product weight shall be 1.0 pounds per square yard +/- 10%.

   B. Staples: Staples shall be made of uncoated steel wire to provide for rapid decomposition. Staples shall be 10-gauge, U-shaped, with a length of 6 inches.

PART 3 EXECUTION

3.1 APPLICATION
   A. The area to be covered shall be prepared, fertilized, and seeded in accordance with Section 02936-Seeding before the blanket is applied.
B. The blanket shall be unrolled down-slope with the plastic netting on top. It is essential that the length of the blanket be parallel to the flow surface runoff. Care should be taken to insure coverage of the entire area as designated without leaving gaps between the blankets. Staples shall be driven through the blanket into the ground at 6-foot intervals along the length of the blanket, and 2-foot intervals along the width of the blanket.

C. Butted joints of adjacent blankets shall be fastened together along the joint with a single row of staples along the length of the blanket. This stapling procedure should result in use of staples at the rate of 0.75 staples per square yard of blanket.

3.2 SCHEDULE

A. Erosion control matting shall be used on all slopes greater than 5:1 and in locations shown on the plans or as directed by the Resident Project Representative.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES
   A. Filter fabric fence

1.2 DESCRIPTION
   A. This Item describes the installation of filter fabric fences utilized during construction and prior to the final development of the site.

1.3 SUBMITTALS FOR REVIEW
   A. Manufacturer's catalogue sheets and other pertinent information on geotextile fabric.

PART 2 PRODUCTS

2.1 FILTER FABRIC
   A. Provide woven or nonwoven geotextile filter fabric made of either polypropylene, polyethylene, ethylene, or polyamide material.

   B. Geotextile fabric shall have a grab strength of 100 psi in any principle direction (ASTM D-4632), Mullen burst strength exceeding 200 psi (ASTM D-3786), and the equivalent opening size of between 20 and 50.

   C. Filter fabric material shall contain ultraviolet ray inhibitors and stabilizers to provide a minimum of six months of expected usable construction life at a temperature range of \(0^\circ\) F to \(120^\circ\) F.

PART 3 EXECUTION

3.1 FILTER FABRIC
   A. Provide erosion and sedimentation control systems at the locations shown on the construction plan/profile sheets or as directed by the Engineer. Such systems shall be of the type indicated and shall be constructed in accordance with the requirements shown on the construction plan/profile sheets and set out in this Item.

   B. Inspect and repair or replace components of all erosion and sedimentation control systems as specified for each system.

      1. Unless otherwise directed, maintain the erosion and sedimentation control systems until the project is accepted by the Owner.
2. Remove erosion and sedimentation control systems promptly, in an appropriate manner, when directed by the Owner.

C. Remove and dispose of sediment deposits off-site.
   1. Off-site disposal will be the responsibility of the Contractor.
   2. Sediment shall not be allowed to flush into streams or drainage ways.
   3. If sediment has been contaminated, it shall be disposed of in accordance with existing federal, state and local regulations.

D. Damage caused by construction traffic to erosion and sedimentation control systems shall be repaired immediately at the expense of the Contractor.

E. Conduct all construction operations under this Contract in conformance with the erosion control practices described.

3.2 CONSTRUCTION METHODS

A. Provide filter fabric fence systems at locations specified in accordance with the construction plan/profile sheets. Filter fabric fence systems shall be installed in such a manner that surface runoff will percolate through the system in sheet flow fashion and allow sediment to be retained and accumulated.

B. Attach the filter fabric and wire to 2 inch by 2 inch wooden stakes or 1.00-1.33 lb./linear foot steel posts spaced no more than six feet apart and embedded at least one foot deep.
   1. All stakes shall be installed perpendicular to the slope of the land.
   2. Steel posts shall have projections for fastening wire and/or fabric.

C. Trench in the toe of the filter fabric fence with a spade or mechanical trencher so that the downward face of the trench is flat and perpendicular to the direction of flow (as shown on the drawing included at the end of this Section).
   1. Lay filter fabric and wire along the edges and bottom of the trench.
   2. Backfill and compact the trench.

D. The filter fabric and wire should be provided in continuous rolls and cut to the length of the Silt Fence to minimize the use of joints.
   1. When joints are necessary, the fabric and wire should only be spliced together at a support post and have at least six inches of overlap.
   2. The joint shall be securely sealed.
E. Inspection of sediment filter barrier systems shall occur after each rainfall or daily during periods of prolonged rainfall. Inspection shall occur at least once a week during rainless periods.

1. Repair or replace damaged section immediately to restore the requirements of this Item.

2. Sediment deposits shall be removed when they reach one-third of the height of the fence.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES
A. This work shall consist of furnishing and installing the sediment log; including fine grading, installing, staking, and miscellaneous related work, in accordance with these standard specifications and at the locations identified on drawings or the owner’s designated representative.
B. The sediment log shall be used to slow water velocity, trap sediment, and enhance re-vegetation. The sediment log shall be suitable for the following applications, channels, swales, ditches, slope interruption, inlet/outlet protection, and perimeter control.

1.2 RELATED SECTIONS
A. Section 02936 - Seeding.

1.3 SUBMITTALS FOR REVIEW
A. UGC Article 8 – Quality Control; Submittals

1.4 QUALITY CONTROL
A. Pre-approved Acceptable Manufacturers
   1. American Excelsior Company, Arlington, Texas
   2. Erosion Control Systems, Inc., Tuscaloosa, Alabama
   3. Ecowattle, Tyler Texas

PART 2 PRODUCTS

2.1 MATERIAL
A. The fill material / filter media is biodegradable, natural hardwood mulch, ground from trees cut for construction. Species and the mix will vary and will include varieties of Maple, Birch, Ironwood, Dogwood, Persimmon, Redbud, Water Locust, Beech, Oak, Sweet gum, Hickory, Pecan, Mulberry, Ash, Red gum, Sycamore and others

   The sizes of the biodegradable hardwood mulch pieces are determined so as to be large enough to create air space for water flow-through, yet small enough to slow high flow water velocities, maintain sufficient filtration levels and stopping slit movement.
B. Netting: The netting is tubular and does not require stitching. It shall be made with a PE Resin / Black with Ecocycle degrading technology tensile strength of (kg): 27+/− 2.
C. Characteristics

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<td>Log Dimensions (W x L)</td>
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PART 3 EXECUTION

3.1 SITE PREPARATION

A. Contractor shall certify that the site is smooth, free of depressions, voids and is free from obstructions such as roots, protruding stones, or foreign matter, and is seeded and fertilized in accordance with the specifications where applicable.

B. No vehicular traffic shall be permitted directly on the sediment log.

3.2 INSTALLATION

A. Sediment logs shall be installed in accordance with the manufacturer's installation guidelines.

B. Sediment logs should be installed to intercept water flow and collect sediment on site. They may be placed over bare soil or on top of erosion control blankets. Sediment logs are typically installed flat on the ground and not in trenches.

C. Secure to ground by wood stakes every two lineal feet or as directed by the manufacturer across the length of the sediment log. The stakes shall be intertwined with the outer mesh of the sediment log only and driven into the ground a minimum of 16 inches on the downstream side of the sediment log.

D. Sediment logs shall remain in place until fully established vegetation and root systems are present.

3.3 CLEAN-UP

A. At the completion of the scope of work, Contractor shall remove from job site and properly dispose of all remaining debris, waste materials, excess materials and equipment required of or created by Contractor.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES
   A. Pipe and fittings for water lines including, supply lines, and potable water distribution lines.
   B. Fire hydrants, fittings, and appurtenances.

1.2 RELATED SECTIONS
   A. UGC Article 8 – Quality Control; Submittals
   B. Section 02205 – Soil Materials
   C. Section 02207 – Aggregate Materials
   D. Section 02225 – Excavation, Backfill, and Compacting for Utilities
   E. Section 15010 – Ductile Iron Piping
   F. Section 15014 – Type 316L Stainless Steel Piping
   G. Section 02669 - Valves and Couplings
   H. Section 03305 – Concrete

1.3 REFERENCES
   A. American Society for Testing and Materials (ASTM)
      2. ASTM A307 – Specification for Carbon Steel Bolts and Studs 60,000 psi Tensile.
      4. ASTM B88 – Seamless Copper Water Tube.
      7. ASTM D1785 – Polyvinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, and 120.


17. ASTM F477 – Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

B. American Water Works Association (AWWA)

1. AWWA C105

2. AWWA C110 – Ductile-Iron and Gray-Iron Fittings, 3 inches through 48 inches, for Water and Other Liquids.

3. AWWA C111

4. AWWA C150

5. AWWA C151

6. AWWA C153 – Ductile Iron Compact Fittings, 3 inches through 12 inches, for Water and Other Liquids.

7. AWWA C502 – Dry-Barrel Fire Hydrants

8. AWWA C511

9. AWWA C600

10. AWWA C900 – Polyvinyl Chloride (PVC) Pressure Pipe, 4 inches through 12 inches, for Water.
11. AWWA C901 – Polyethylene (PE) Pressure Pipe, Tubing, and Fittings, ½ inch through 3 inches for Water.

12. AWWA C905.

C. National Sanitation Foundation (NSF)


D. American National Standards Institute (ANSI).

1. ANSI B16.9 – Fittings.

2. ANSI B36.19 – Wall Thickness.


4. ANSI B16.1 – Flanges and Flanged Fittings.

E. Texas Administrative Code, Volume 30, Chapter 290, Water Hygiene.

1.4 SUBMITTALS

A. Procedures for Submittals: UGC Article 8 – Quality Control; Submittals

B. Product Data: Manufacturer’s product data sheets on all materials incorporated into work.

C. Quality Control Submittals: For information only.

1. Certificates: Manufacturer's certificates attesting compliance with applicable specifications for grades, types, classes, and other properties.

2. Test Reports: Results of field quality control tests including hydrostatic tests and bacteriological tests.

D. Contract Closeout Submittals: Refer to UGC Article 12 – Project Completion and Acceptance & Special Conditions Paragraph 1.12 – Contract Completion.

1. Project Record Documents: Submit documents in accordance with Special Conditions Paragraph 1.13 – Contract Close-out. Accurately record installed location of valves, hydrants, piping and service connections, and accessories.

1.5 QUALITY ASSURANCE

A. Pipeline installation shall be in accordance with manufacturer's recommendations and as supplemented by these specifications.
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B. Pipe shall be kept clean of all foreign matter.
C. Jointing shall be by trained employees.

1.6 DELIVERY, STORAGE, AND HANDLING
A. Each load of pipe delivered to the job site shall be inspected by the Engineer.

1. Pipe transported without adequate protection shall be rejected and removed immediately from the job site.

2. Inadequate wall thickness or tolerances greater than specified: Randomly selected samples of the pipe shall be forwarded immediately to an approved testing laboratory with instructions to check the pipe for compliance with applicable product standards, ASTM Specifications, and other applicable specifications.

3. When the testing laboratory reports concur that the pipe does not meet specifications, the defective pipe shall be removed immediately from the job site by the Contractor.

4. If defective, all costs for shipping of samples, laboratory testing, removal of defective pipe, and replacement pipe shall be the sole responsibility of the Contractor.

PART 2 PRODUCTS

2.1 PIPE
A. 316L STAINLESS STEEL PIPE—SEE SPECIFICATIONS
B. PVC Water Pipe - AWWA C900 or AWWA C905 Restrained Joint

1. DR 18 – Pressure, Class 235.

2. All pipe shall bear NSF seal of approval.

3. Joints shall be integral bell with flexible elastomeric seal.

2.2 FITTINGS
A. Fittings (two inches and larger in diameter)

1. Fittings shall be ductile iron according to AWWA C110 (full body) for fittings 2 inches in diameter and larger than 12 inches in diameter or AWWA C153 (compact) for fittings three inches through 12 inches in diameter.

2. Interior surfaces shall be cement lined in conformance with AWWA C104.

3. Exterior surfaces shall be bituminous coated in accordance with AWWA C104.
4. Fittings shall have mechanical joints with thrust restraint unless otherwise specified or shown. Any of the following are acceptable types and manufacturers of thrust restraining devices for the pipe types listed unless otherwise specified or shown on the plans. The method for thrust restraining all joints shall have a working pressure rating equal to or exceeding the pressure rating of the fitting which it restrains.

   a. Multiple Gripping Wedges

      1) Follower glands utilizing multiple gripping wedges shall utilize torque limiting twist off nuts.

      2) Pre-Approved Manufacturer

         (a) For use on AWWA C900 and C905 PVC pipe - Series 2000PV by EBAA Iron, Inc.

         (b) For use on ductile iron pipe – Series 1100 by EBAA Iron, Inc.

   b. Full Circle Gripping Ring

      Pre-Approved Manufacturer for use on ductile iron pipe and AWWA C900 and C909 PVC pipe – Midco Perma-Grip by Midland Mfg. Co.

2.3 COUPLINGS

   A. Supply couplings with a steel center band, steel gland rings, gaskets, and bolts.

   B. Couplings shall be rated for 1.25 times the maximum operating pressure of the line to be connected.

   C. All couplings near bends, fittings, or valves shall be restrained with an Engineer approved mechanical restraint system.

   D. Pre-approved Manufacturers

      1. Dresser Industries.

      2. Smith-Blair.

2.4 FLANGE ADAPTORS

   A. Restained flange adaptors shall be used in place of threaded or welded flange pieces only where specified or shown on the plans.

   B. Restraint for the flange adaptor shall consist of a number of individual gripping wedges. Torque limiting actuating screws shall be used to insure proper initial set of the gripping wedges.
C. For PVC pipe, the flange adaptor shall have a pressure rating equal to that of the pipe. For ductile iron pipe, the flange adaptor shall have a safety factor of 2:1 minimum.

D. The flange adapter shall be the Series 2100 Megaflange adaptor as manufactured by EBAA Iron, Inc. or engineer approved equal.

2.5 BOLTS AND GASKETS

A. Gaskets shall be 1/16-inch cloth insert, red rubber, full face-regular water service

B. Gaskets shall be 1/16-inch Teflon, full face rated for ozone gas and ozone in solution service

C. Bolts shall be in accordance with the following:
   1. Non-Pressure Applications: ASTM A307A.
   2. Pressure Applications: ASTM A307B.

D. Bolts and nuts for buried flanges, for all specified piping materials, shall be Type 316 stainless steel meeting the requirements of ASME B18.2.1.

2.6 PIPE SUPPORTS

Install adjustable pipe supports manufactured by Anvil International Inc. or Engineer approved equal as shown on the plans.

2.7 PRESSURE GAUGES

A. The gauges shall be as manufactured by Marshalltown Instruments, Ashcroft, Dresser Industries, Weksler, or approved equal and shall be the Manufacturer’s standard commercial product. Gauge cases shall be phenol or ABC plastic, or steel zinc-coated or phosphate treated and finished with black enamel. 3. Gauges shall have a 4” face. Inlet shall be ¼” size with bottom connections.

B. Class 1 gauges shall be pressure-indicating. Class 2 gauges shall be vacuum gauge-designed for vacuum indications. Class 3 gauges shall indicate pressure or vacuum.

C. At each pressure gauge, furnish and install a pulsation dampener, Mid-West Model 150, Vari-Damp Pulsation Dampener, or approved equal.

D. Gauge cocks for isolating standard product gauges shall be heavy duty brass with tee handle and male and female ends for ¼” bottom threaded connections.
2.8 SERVICE LINES
   A. Water service lines shall consist of 1” CTS polyethylene tubing 200 psi and shall conform to AWWA specification C-901 unless otherwise specified or shown.
   B. Service Saddles
      1. Service saddles to be installed on lines up to four inches shall be single stainless steel strap with NPT tap. Service saddles to be installed on lines over four inches shall be double stainless steel strap with NPT tap. Saddle body shall be ductile iron with epoxy coating.
   C. Corporation Stops
      1. Corporation stops shall be bronze with tapered plug and flat key operator. Stops shall have iron pipe threads on inlets and outlets.

2.9 TRACER WIRE FOR PVC PIPE
   A. A continuous THHN 14 solid insulated copper wire shall be installed along with all PVC water mains to assist in locating the line following installation.

PART 3 EXECUTION
3.1 PREPARATION
   1. Inspect, unload, handle, and store materials as set forth in AWWA C600 and as specified.
   2. Do not lay pipe in water, or when trench or weather are unsuitable for work. Keep water out of trench until jointing is complete and bedding is placed to top of pipe. When work is not in progress, close ends of pipe and fittings securely so that no trench water, earth or other substances will enter pipes or fittings.
   3. Keep inside of pipe free from foreign matter during operations by plugging or other approved method.
   4. Place pipe so that full length of each section rests solidly upon pipe bed, with recesses excavated to accommodate bells and joints. Take up and re-lay pipe when grade or joint is disturbed after laying.
   5. Handle pipe and accessories so that pipe placed in trench is sound and undamaged. Take particular care not to injure pipe coating when applicable.
   6. Cut neatly, using approved type mechanical cutter without damaging pipe. Use wheel cutters when practicable.
   7. Install in locations sited with hangers, brackets, supports, etc., at spacings as recommended by pipe manufacturer.
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8. Field cutting of stainless steel pipe will not be allowed.

3.2 PIPE BEDDING AND BACKFILL
A. Pipe Bedding and Backfill: In accordance with Section 02225 - Excavation, Backfilling, and Compacting for Utilities and embedment detail as shown in the plans.

3.3 PLACING AND LAYING
A. Bury water lines as shown. The minimum cover for pipe 30 inches and less in inside diameter is 36 inches unless as shown in the plans otherwise. The minimum cover for pipe larger than 30 inches in inside diameter is 48 inches unless as shown in the plans otherwise.

B. Intersecting lines shall be joined by an appropriate fitting.

3.4 JOINTS
A. Install mechanical joints in accordance with the manufacturer's recommendations.

B. Make push-on joints in accordance with the manufacturer's recommendations.

C. Install solvent weld joints in accordance with ASTM D2855.

D. Joint lubricant shall be as recommended by the pipe manufacturer.

E. Install joints in the field by cleaning all joint surfaces and gaskets with soapy water, tighten bolts alternately, evenly and to the specified torques. Extension wrenches shall not be used to secure greater leverage. Install electrical bonding or insulation during installation of joints.

F. Complete installation of pipe and appurtenances as set forth in AWWA C600 and as specified.

3.5 Anchor tees, bends and plugged, valved or capped ends of pipe with concrete thrust blocks as necessary and as shown. Place blocks so that the pipe and fitting joints will be accessible for inspection and repair.

3.6 Water lines shall not be laid within nine feet of sanitary sewer lines. When this separation distance can not be achieved, the water and sewer lines shall be made to comply with 30 TAC Chapters 290 and 217. Contractor shall notify engineer upon discovery of minimum separation distance not being met.

3.7 TESTING
A. TEST REQUIREMENTS (ALL PIPING)

1. Perform tests on piping systems including piping installed between structures or connected to existing pipe.
2. Conduct tests on buried pipe to be hydrostatically tested after the trench is completely backfilled. If field conditions permit and if approved by the Engineer, partially backfill the trench and leave the joints open for inspection and conducting of the initial service leak test. Do not conduct the acceptance test until backfilling is complete.

3. Conduct the test on exposed piping after the piping is completely installed, including supports, hangers, and anchors, but prior to insulation.

4. Do not perform testing on pipe with concrete thrust blocking until the concrete has cured for at least five days.

5. Determine and remedy the cause of excessive leakage for any pipe failing to meet the specified requirements for water or air tightness.

6. Tests must be successfully completed and reports filed before piping is accepted.

7. Submit the plan for testing to the Engineer for review at least 10 days before starting the test.

8. Remove and dispose of temporary blocking material and equipment after completion and acceptance of the piping test.

9. Repair any damage to the pipe coating.

10. Clean pipelines so they are totally free flowing prior to final acceptance.

11. Test piping independently from tests on structures.

12. Test method and test pressure depend upon the application of the piping.

   a. Pressure pipe is defined as piping that is part of a pumped or pressurized system. Perform testing for pressure pipe per the procedures indicated in paragraph B of this section.

   b. Gravity pipe is defined as piping that depends upon the force of gravity for flow through the pipe. Perform testing for gravity pipe per the procedures indicated in paragraph C, D, or E of this section.

   c. Chemical processing lines are to be tested as pressure pipe regardless of the operating conditions. The test pressure is to be 1.5 times the pressure rating of the pipe.
B. PRESSURE AND LEAKAGE TESTS OF PRESSURE PIPING

1. Leakage tests shall be performed on all water distribution system piping and pressure rated sewer piping (ASTM 2241).

2. Perform hydrostatic pressure and leakage tests using methods and performance requirements of Section 4 of AWWA C600.
   a. The pressure required for the hydrostatic pressure test shall be 50 percent above the normal working pressure. If the normal working pressure cannot be determined, use the pipe pressure rating as the normal working pressure.
   b. Provide temporary plugs and blocking necessary to maintain the required test pressure. Where piping is cast in the walls for a structure, brace the walls prior to testing as required to prevent load of test pressure from being imposed upon the structure.
   c. Provide corporation cocks at least ¾ inch in diameter, pipe riser, and angle globe valves at each pipe dead-end in order to bleed air from the line.
   d. The duration of the pressure test shall be at least 24 hours.

3. Perform a separate leakage test after the pressure test.
   a. Perform the test at the maximum operating pressure as determined by the Engineer for a duration of not less than two hours.
   b. Repair any visible leaks regardless of the total leakage shown by the test.
   c. Repair pipelines which fail to meet the test and retest as necessary until the results conform to the test requirements.
   d. Remove and replace defective materials, pipes, valves, and accessories.
   e. Test the pipelines in sections by shutting valves or installing temporary plugs as necessary.
   f. Fill the pipeline with water and remove the air.
   g. Maintain the test pressure in the pipe for the entire test period by means of a force pump.
   h. Accurately measure the water required to maintain the pressure. The amount of water required is a measure of the leakage.
The maximum allowable leakage is determined by the following formulas.

**Ductile Iron Pipe**

\[ L = \frac{S D(P)^{1/2}}{133,200} \]

L is the allowable leakage in gallons per hour.
S is the length of pipe tested in feet.
D is the nominal diameter of the pipe in inches.
P is the test pressure in pounds per square inch gauge.

**PVC Pipe**

\[ L = \frac{N D(P)^{1/2}}{7,400} \]

L is the allowable leakage in gallons per hour.
N is the number of joints in the length of line tested.
D is the nominal diameter of the pipe in inches.
P is the test pressure in pounds per square inch gauge.

Leakage is defined as the volume of water provided to maintain the test pressure after the pipe has been filled with water, the air expelled, and the pipe brought to test pressure.

4. Pipe with visible leaks or leakage exceeding the maximum allowable leakage is considered defective and must be corrected.

**C. LOW-PRESSURE AIR TEST**

1. Use the air test in lieu of the hydrostatic test if desired or if pipeline grades do not allow filling the entire pipeline segment or manhole to the indicated depth.

2. Perform low-pressure air tests using equipment specifically designed and manufactured for the purpose of testing sewer pipelines using low-pressure air. The test is to conform to procedures described in ASTM C828, ASTM C924, or other Engineer approved procedures.
   a. Provide equipment with an air regulator valve or air safety valve set to an internal air pressure in the pipeline that cannot exceed six psig.
   b. Pass air through a single control panel.
   c. Provide pneumatic plugs that have a sealing length equal to or greater than the circumference of the pipe to be tested.
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d. Provide pneumatic plugs that resist internal test pressures without requiring external bracing or blocking.

e. Provide an air compressor of adequate capacity for charging the system.

3. Perform air test only on lines less than 36 inches diameter. Air tests for pipes larger than 36 inches may be tested at each joint.

4. Check connections for leakage with a soap solution. If leaks are found, release the air pressure, repair the leak, and retest with soap solution until results are satisfactory before resuming the air test.

5. Determine the maximum allowable time for the pressure to drop from 3.5 pounds per square inch to 2.5 pounds per square inch.

\[ T = \frac{0.085 \times D \times K}{Q} \]

T is the time for the pressure to drop 1.0 pound per square inch gauge in seconds.
K is 0.000419DL, but not less than 1.0.
D is the average inside diameter in inches.
L is the length of line of the same pipe size in feet.
Q is the rate of loss (use 0.0015).
Since a K value of less than 1.0 shall not be used, there are minimum testing times for each pipe diameter as follows

<table>
<thead>
<tr>
<th>Pipe Diameter (Inches)</th>
<th>Minimum Time (seconds)</th>
<th>Length for Minimum Time (feet)</th>
<th>Time for Longer Length (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>340</td>
<td>398</td>
<td>0.855(L)</td>
</tr>
<tr>
<td>8</td>
<td>454</td>
<td>298</td>
<td>1.520(L)</td>
</tr>
<tr>
<td>10</td>
<td>567</td>
<td>239</td>
<td>2.374(L)</td>
</tr>
<tr>
<td>12</td>
<td>680</td>
<td>199</td>
<td>3.419(L)</td>
</tr>
<tr>
<td>15</td>
<td>850</td>
<td>159</td>
<td>5.342(L)</td>
</tr>
<tr>
<td>18</td>
<td>1020</td>
<td>133</td>
<td>7.693(L)</td>
</tr>
<tr>
<td>21</td>
<td>1190</td>
<td>114</td>
<td>10.471(L)</td>
</tr>
<tr>
<td>24</td>
<td>1360</td>
<td>100</td>
<td>13.676(L)</td>
</tr>
<tr>
<td>27</td>
<td>1530</td>
<td>88</td>
<td>17.309(L)</td>
</tr>
<tr>
<td>30</td>
<td>1700</td>
<td>80</td>
<td>21.369(L)</td>
</tr>
<tr>
<td>33</td>
<td>1870</td>
<td>72</td>
<td>25.856(L)</td>
</tr>
</tbody>
</table>

The test may be stopped if no pressure loss has occurred during the first 25% of the calculated testing time. If any pressure loss or leakage has occurred during the first 25% of the testing period, then the test shall continue for the entire test duration as outlined above or until failure.
D. *Upon completion of all required testing, the contractor shall provide a signed and notarized affidavit certifying that the system has been tested and meets applicable requirements.*

3.8 Do not enclose or cover any work until inspected.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES

A. This section includes all material, labor and other items necessary to furnish, install, and test, all valves, weir gates, and special items as shown and specified, and the installation of in-line equipment and appurtenances for process piping systems, and plumbing piping systems.

1.2 RELATED SECTIONS

A. UGC Article 8 – Quality Control; Submittals
B. Section 02205 – Soil Materials
C. Section 02207 – Aggregate Materials
D. Section 02225 – Excavation, Backfill, and Compacting for Utilities
E. Section 15010 – Ductile Iron Piping
F. Section 15014 – Type 316L Stainless Steel Piping
G. Section 02665 – Water Systems
H. Section 03305 – Concrete

1.3 SUBMITTALS

A. The Contractor shall submit shop drawings of all fabricated piping and shall submit shop drawings and/or manufacturer's literature for all valves, gauges, and miscellaneous appurtenances, for review prior to ordering or installing any item.

PART 2 PRODUCTS

2.1 COUPLINGS AND FITTINGS

A. Flanges, Gaskets and Bolts

1. Cast iron flanges shall conform to ANSI B16.1 Class 125 or 250 as required on the Drawings. Flange gaskets shall be full face type, rubber, suitable for the intended service. Gaskets for blower air supply systems shall be rated for high
operating temperatures. Substitution of other gasket materials shall be only with the express written consent of the Engineer. Thickness shall be 1/16" for pipe 10" diameter and less and 1/8" for pipes larger than 10" diameter. Flange assembly bolts shall be standard square head carbon steel machine bolts with heavy, hot pressed, hexagon nuts, ANSI B18.2. Threads shall conform to ANSI B1.1, coarse thread series, Class 2 fit. Bolt length shall be such that after joints are made up the bolt shall protrude through the nut, but not more than ½". Nuts, bolts, and washers for use in submerged service shall be stainless steel. All screwed flanges on cast iron pipe shall be refaced, as required, after fabrication to ensure that pipe ends are flush with face of flange.

2. Forged steel flanges shall conform to ANSI B16.5, R.F. Flange gaskets shall match raised faces and shall be asbestos composition. On 3½" flanges and smaller, gaskets shall be 1/16" thick. On 4" flanges and larger, gaskets shall be 1/8" thick. Flange assembly bolts shall be standard square head carbon steel machine bolts with heavy, hot pressed hexagon nuts, ANSI B18.2. 150 psi steel flanges may be bolted to cast iron valves, fittings or other parts, having either integral Class 125 cast iron flanges or screwed Class 125 companion flanges. When such construction is used, the raised face on the steel flange shall be removed. Where shown on the Drawings, steel flanges shall match the bolt pattern of ANSI B16.1 Class 250. Nuts, bolts, and washers for use in submerged service shall be stainless steel.

B. Pipe Threads

1. Unless noted otherwise, all pipe threads shall conform in dimensions and limits of size to ANSI B2.1, taper joint thread.

C. Flange Coupling Adapters

1. Flanged coupling adapters shall be Clow F-2535, Dresser Style 127 or 128, or equal. Coupling gaskets shall be as recommended by the coupling manufacturer for the service intended.

D. Mechanical Pipe Couplings

1. Mechanical pipe couplings shall be Dresser Style 38, Smith-Blair Type 411, or equal. Mechanical pipe couplings for buried cast or ductile iron shall be cast iron couplings.

2. Coupling gaskets shall be as recommended by the coupling manufacturer for the service intended.

E. Compression Fittings

1. Compression fittings for copper pipe shall be Dresser Style 88, McDonald, or equal.
F. Pipe Joints

1. Joints of mechanical installations inside structures and of yard piping shall be as detailed on the Plans. Where not detailed on the Plans, all pipelines installed under structures shall be mechanical joint pipe as well as the first joint outside of buildings shall be mechanical type. Ductile iron retainer glands shall be used in all mechanical joints.

2. All other joints not listed above or detailed on the Plans shall be mechanical type or push-on type. Lubricant for push-on type shall be that recommended by the manufacturer of the pipe.

G. Flexible Couplings

1. There shall be installed where shown on the Plans and as required for proper pipe make-up, sleeve-type couplings equal to Style 38 couplings, as manufactured by the Dresser Manufacturing Division of Dresser Industries. They shall be designed to fit accurately, the outside diameters of the pipe to which they are to connect. Gaskets shall be of molded rubber, Dresser Plain, Grade 27 or equal. Couplings shall be furnished complete with bolts, nuts, and gaskets. Middle rings shall be made up without a pipe stop where necessary for pipe installation or future removal of valves and fittings.

2. The ends of pipe and fittings which are to receive sleeve-type couplings shall be dressed for a distance of not less than the length of the middle ring plus the width of one follower ring in order to remove welding beads or any obstruction to free the movement of the middle ring. There shall be harnesses provided on steel pipe where shown on the Plans, or as necessary for restraint. The harnesses shall be designed for the design operating pressure of the pipeline with a safety factor of 2. The harnesses are to be designed in accordance with AWWA Manual M11, Steel Pipe Design and Installation.

2.2 VALVES

A. General

1. Valves shall be as specified in the Piping Specification Sheets, or as specified herein. A union or flagged connection shall be provided within 2 feet of each threaded end valve unless the valve can be otherwise easily removed from the piping. Unless otherwise indicated, the direction of rotation of the valve operating wheel, wrench nut, or lever shall be to the left (counterclockwise) to open the valve.
2. All valves, except those which are equipped with power operators shall be provided with manual operators. Unless otherwise specified, each manual operator shall be equipped with an operating wheel.

3. Chain wheels and operating chains shall be provided on all valves 4" and larger with centerline more than 7'6" above the floor except where other operator types are specifically required. Each chain wheel operated valve shall be equipped with a chain guide which will permit rapid handling of the operating chain without "gagging" of the wheel and will also permit reasonable side pull on the chain. Operating chains shall be heavily plated with zinc or cadmium and shall be looped to extend to within 4 feet of the floor below the valve. Where recommended by the manufacturer, the operator shall be provided with a hammer blow wheel.

4. Wrench nuts shall be provided on all buried valves, on all valves which are to be operated through floor boxes, and where shown. All wrench nuts shall comply with Section 20 of AWWA C-500. Not less than two operating keys shall be provided for operation of the wrench nut operated valves.

5. For all valves buried at a depth of greater than 3 feet, an extension stem shall be provided to bring the operating nut within 3 feet of the finished elevation.

6. Bolt patterns for the flange connections shall match the pipe either Class 125 or Class 250 as shown on the plans.

B. Gate Valves

1. Gate valves, two (2) inches through twelve (12) inches shall be designed for a minimum working pressure 200 psi. Valves shall conform to AWWA C509-87 with iron bonnet (bronze mounted), non-rising stem resilient seat, two O-ring stem seals and 2" x 2" square operating nut. Valves shall open when the operating nut is turned to the left (counterclockwise). Unless otherwise specified, valves twelve (12) inches in diameter and larger shall be design for horizontal installation with totally enclosed gear cases. Valve ends shall be mechanical joint complete with accessories or as specified.

2. Wedge shall be constructed of ductile iron, fully encapsulated in synthetic rubber except for guide and wedge nut areas.

3. Wedge rubber shall be molded in place and bonded to the ductile iron portion, and shall not be mechanically attached with screws, rivets, or similar fasteners.

4. Valve boxes shall be the H-10346, 562-A, two-piece, sliding type, 5½" shaft, 24" to 36" extension, with drop cover marked water as manufactured by the Mueller Co. or equal. Valve boxes shall be set vertical and concentric with the valve stem. Any
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valve box which is moved from its original position as to prevent the application of the valve key shall be satisfactorily reset by the Contractor at his own expense.

5. Except as may be otherwise approved by the Engineer, all gate valves required for this Contract shall be from one manufacturer, and similar types and sizes shall be identical and the parts interchangeable.

6. Valve operator shall be capable of seating and unseating valves and operating through their full stroke against pressures and velocities as shown by conditions on the Plans.

7. Manual operators shall be the worm gear type having permanently grease lubricated totally enclosed gearing with operating nut and gear ratio design to require not more than 40 pounds pull. Operator shall be provided with adjustable limit stops on the input shaft to the operator. Limit stops on output shaft of operator will not be permitted. Operator shall be designed for direct burial service and valve box shall be provided over operating nut. Extension stem shall be provided to bring operating nut within 3 feet of ground surface.

C. Butterfly Valves (Non-Ozone Service)

1. Unless specified otherwise, butterfly valves shall be of the tight closing, rubber seated type with cast iron bodies and rubber seats that are cemented and mechanically clamped into the valve body. All valves shall be furnished in strict accordance with AWWA "Rubber Seated Butterfly Valves" C-504 Class 150 with a rated working pressure.

2. Valve body shall be of close-grained cast iron ASTM A-126 Class B with integrally cast hubs for shaft bearings. Valve shall have 125 pound flange ends (or 250 pound if called for by the Plans) faced and drilled in accordance with ASA Standards, or "wafer" type valves, or mechanical joint ends as indicated on the Drawings.

3. Valve discs shall be of symmetrical 1-piece ductile ASTM A-536 with stainless steel seating edge. Adjustable mechanical stops shall be provided to limit rotation.

4. Valve shafts shall be of 1-piece design projecting completely through valve disc and made of stainless steel type 304 or 316. Each valve shaft shall be securely attached to valve disc by means of pins extending through disc and shaft.

5. Valve seat shall be of synthetic rubber securely retained into valve body for complete immobility under all operating conditions. Mechanical clamping means used to clamp valve seat shall be of non-corrosive construction. Valve seat shall
be replaceable without dismantling the valve operator, disc or shaft and without removing the valve from the line.

6. Shaft bearing shall be of the self-lubricating sleeve type bronze impregnated with silicone oil. An adjustable 2-way thrust bearing shall be provided to keep disc centered regardless of valve position.

7. Valves shall be furnished with extension bonnets and operators as required.

8. Valve discs shall seat at 90° to the axis of the valve and revolve through 90° from full open to closed.

9. Valve operator shall be capable of seating and unseating valves and operating through their full stroke against a working pressure of 150 psi and velocities up to 15 feet per second.

10. All valves shall have worm gear type operators having permanently grease lubricated, totally enclosed gearing with operating nut and gear ratio design to require not more than 40 pounds pull. Operator shall be provided with adjustable limit stops on the input shaft to the operator. Limit stops on output shaft of operator will not be permitted. Operator shall be designed for direct burial service and valve box shall be provided over operating nut or for above ground operators as shown on the Drawings. For manually operated valves, extension stem and operating nut shall be provided to bring operating nut within 6-inches of the finished ground elevation. Cast iron valve boxes shall be provided with all valves.

11. Where electrically operated valves are specified, the valve actuator shall be located above ground as shown on the Plans. Appropriate extensions shall be provided to connect the electric actuator to the underground operator. The electric operator shall be designed to move the valve a minimum of 90 degrees in each direction and must be able to overtravel at 3% in each direction past 90 degrees. Valve, reducer, operator and accessories shall be furnished complete, ready for installation, from a single manufacturer. Housing shall be heavy, cast aluminum and fully gasketed to operate in high humidity environments. Actuator shall be weatherproof. Gears and gear shafts shall be alloy steel and heat treated for hardness. All shafts shall mount in friction-reducing bearings. Gear box housing shall be grease filled and sealed. No lubrication shall be required for the life of unit. Manual operation shall be available and shall be accomplished by means of a shaft, equipped with wrench flats, that extends through a sealed opening in the housing.

D. Butterfly Valves (Ozone Service)

1. Butterfly valves for ozone service, as indicated in the plans, shall be fully constructed of 316 stainless steel.
2. Valve body shall be 316 stainless steel. Valve shall have 125 pound flange ends (or 250 pound if called for by the Plans) faced and drilled in accordance with ASA Standards, or "wafer" type valves, or mechanical joint ends as indicated on the Drawings.

3. Valve discs shall be 316 stainless steel. Adjustable mechanical stops shall be provided to limit rotation.

4. Valve shafts shall be of 1-piece design projecting completely through valve disc and made of 316 stainless steel. Each valve shaft shall be securely attached to valve disc by means of pins extending through disc and shaft.

5. Valve seat and seal shall be PTFE.

6. Valves shall be furnished with extension bonnets and operators as required.

7. Valve discs shall seat at 90° to the axis of the valve and revolve through 90° from full open to closed.

8. Valve operator shall be capable of seating and unseating valves and operating through their full stroke against a working pressure of 150 psi and velocities up to 15 feet per second.

9. All valves shall have worm gear type operators having permanently grease lubricated, totally enclosed gearing with operating nut and gear ratio design to require not more than 40 pounds pull. Operator shall be provided with adjustable limit stops on the input shaft to the operator. Limit stops on output shaft of operator will not be permitted. Operator shall be designed for direct burial service and valve box shall be provided over operating nut or for above ground operators as shown on the Drawings. For manually operated valves, extension stem and operating nut shall be provided to bring operating nut within 6-inches of the finished ground elevation. Cast iron valve boxes shall be provided with all valves.

10. Where electrically operated valves are specified, the valve actuator shall be located above ground as shown on the Plans. Appropriate extensions shall be provided to connect the electric actuator to the underground operator. The electric operator shall be designed to move the valve a minimum of 90 degrees in each direction and must be able to overtravel at 3% in each direction past 90 degrees. Valve, reducer, operator and accessories shall be furnished complete, ready for installation, from a single manufacturer. Housing shall be heavy, cast aluminum and fully gasketed to operate in high humidity environments. Actuator shall be weatherproof. Gears and gear shafts shall be alloy steel and heat treated for hardness. All shafts shall mount in friction-reducing bearings. Gear box housing shall be grease filled and sealed. No lubrication shall be required for the life of
unit. Manual operation shall be available and shall be accomplished by means of a shaft, equipped with wrench flats, that extends through a sealed opening in the housing.

E. Plug Valves

1. Valves shall be of the non-lubricated, eccentric type with resilient face plugs with flagged ends for pump stations and mechanical joint for buried service. Port areas of valves shall be at least 80% of full pipe area. Bodies shall be semi-steel with seats. Seats in 3" and larger valves shall be pure nickel or stainless steel on all surfaces contacting the plug face. Valves shall have permanently lubricated, stainless steel bearings in the upper and lower plug stem journals.

2. All valves shall be of the bolted bonnet design. All 4" and larger valves shall be designed so that they can be repacked without removing the bonnet and the packing shall be adjustable. All nuts, bolts, washers, and springs for exposed valves located in finished piping of pump stations shall be zinc plated. Flanged valves shall be faced and drilled to ANSI B16.1 Class 125 or as called for by the Plans. Flanges of valves through 12" shall have face-to-face dimensions of standard gate valves.

3. Resilient plug facings shall be of neoprene suitable for use with raw water and potable depending on the service application. Plugs valves shall be designed for proper operation within the system whether gravity or pressure systems. The plug valve shall be designed so as to eliminate “slamming” closed or damage to the plug or seal due to cavitation from operating conditions.

4. Valves shall have gear actuators and tee wrenches, extension stems, etc., as required for either submerged or exposed service. All valves 6" and larger shall be equipped with gear actuators. All gearing shall be enclosed in semi-steel housing and be suitable for running in a lubricant with seals provided on all shafts to prevent entry of dirt and water into the actuator. The actuator shaft and the quadrant shall be supported on permanently lubricated bronze bearings. Actuators shall clearly indicate valve position and an adjustable stop shall be provided to set closing torque.

5. Valves and gear actuators for buried or submerged service shall have seals on all shafts and gaskets on the valve and actuator covers to prevent the entry of water. Actuator mounting brackets for buried or submerged service shall be totally enclosed and shall have gasket seals. All exposed nuts, bolts, springs, and washers shall be stainless steel. Valves shall be Series 800 X-centric plug valves as manufactured by Dresser, Series 100 plug valves by DeZurik, or equal.

F. Ball Valves
1. Ball valves may be used in piping systems 2" in diameter and smaller. Valves shall be plastic or steel for line pressure up to 100 psi and steel for line pressures over 100 psi.

2. Plastic ball valves shall be constructed from thermoplastic polyvinyl chloride. Valves shall be of the cartridge type, with locked-in seal carriers, ethylene propylene rubber "O" ring seals, and Teflon seats. Valves shall be double entry, true-union threaded and coupled. Where shown on the Plans, furnish flagged valves with 125 psi flanges. Plastic ball valves shall be as manufactured by Balon Corporation, Oklahoma City, OK, or equal.

3. Steel ball valves shall be of 2-piece construction with internally seated stem. Provide precision machined mating surfaces, stem stop integral with body, and multi-seal seats. Ball shall be plated and polished. Provide each valve with lever operator. Steel ball valves designed for general service applications up to 1000 pounds working pressure shall be as manufactured by Balon Corporation, or equal.

G. Globe Valves

1. Globe valves may be used when designated in piping system and for applications of 3" and smaller. Furnish globe valves rated for 150 pound working pressure. Insure design is arranged to permit re-packing of stuffing box with valve under operating pressure.

2. When designated in piping system and for applications larger than 3", furnish all brass globe valves with brass disc. Provide screwed or flagged ends in accordance with AWWA Standards. Drill flanges in accordance with 125 pound ASA. Provide globe or angle type valves as required. Design valve packing to allow re-packing while under pressure. Furnish valves rated for 150 pounds working pressure.

H. Solenoid Valves

1. Provide solenoids using 115V, 60 cycle, single phase power unless otherwise noted. Provide solenoid valve equal to those listed in valve schedules in both construction and operation. Furnish solenoid valves equal to those manufactured by the Automatic Switch Co. of Automatic Valve Co.

I. Valve Marking

1. All exposed valves shall be tagged with identifying numbers as shown on the Drawings. Tags shall be 2" diameter brass, Style No. 300-BL as manufactured by Seton Name Plate Corporation, or equal. Tags shall be fastened with brass chain and "S" hooks.

J. Weir Gates:
1. Guide Frame: The wall mounted and embedded guide frame shall be of extruded aluminum, incorporating Hercules, Incorporated or Allied Chemical ultra high molecular weight polymer (UHMW) bearing bars having an intrinsic viscosity of greater than 14 by test. The UHMW bearing bars shall reduce the coefficient of friction to .125 from that of metal to metal contact, thus reducing wear on the gate and operator.

2. The yoke to support the operating benchstand will be formed by two channels welded at the top of the guides to provide a one-piece rigid frame. All gate frames shall have a heavy coat of bituminous paint where the guide is in contact with the concrete. All necessary attaching bolts and anchor bolts will be furnished by the gate manufacturer. Holes for anchor bolts shall be provided every 18". All grout used between the frame and structure shall be non-shrink cement based grout.

(a) Embedded Type: The self-contained guide frames shall be designed for maximum rigidity and provided with keyways to lock the frame into the concrete. Guide for the embedded gates shall have a weight of not less than 3 lbs per ft. and shall contain UHMW bearing bars upstream and downstream of the gate. The guides shall be sufficiently strong so that no further reinforcing will be required where the guides extend above the operating floor.

(b) Wall Mounted Type: The self-contained guide frames shall be designed for maximum rigidity. Guides for these seated wall mounted gates shall have a weight of not less than 4 lbs per ft. and shall contain UHMW bearing bars downstream of the gate. The guides shall be sufficiently strong so that no further reinforcing will be required where the guides extend above the operating floor.

3. The flush bottom invert of the frame will be extruded aluminum, shall have a weight of not less than 2.5 lbs. per ft., will be provided with keyways to lock it into the concrete and will be furnished with a neoprene insert which shall function as a seating surface for the plate.

4. The gate or sliding member will be of 1/4" aluminum plate reinforced as required so that the plate will not deflect more than 1/360 of the span of the gate under the designed head. All parts of the gate will have a minimum thickness of 1/4".

5. Operation of the gate will be by means of an antifriction handwheel benchstand. The bronze operating nut will be accurately machined and internally threaded to accept the rising stem counterpart. Maximum effort on the handwheel shall not exceed 40 lbs. pull to open or close the gate. A position indicator shall be incorporated into the operator system. A stem cover will be provided above the operator. The lift mechanism must be capable of withstanding, without damage, an effort up to 200 lbs.
6. The operating stem (Type 304 stainless steel) will be connected to the plate by means of an extruded aluminum connector bolted to the stem and welded to the plate and the top gate stiffener. The stem will be designed to have an L/R of less than 200 and have a minimum diameter of 1½". Stem guides shall be provided if required. An adjustable stop collar shall be provided on each stem to limit both upward and downward travel on gate systems having mechanical lifts.

7. All stems shall be equipped with a graduated clear plastic stem cover. All stems for weir gates shall be equipped with counter type position indicators to show the position of the gate in tenths of an inch.

8. Each gate system will be designed to open fully to the top of wall elevation or to achieve a full open port unless otherwise shown on the Contract Drawings or specified herein.

9. A side mount or front mount operator system utilizing right angle bevel boxes, stainless steel interconnecting shafting, and flexible couplings shall be furnished by the manufacturer when the benchstand is located over 48" above the top of the concrete or operator standing level. The transmission system design shall provide for the gate to be operated from a position 30" above the concrete.

10. Bevel boxes for the transmission system shall be provided with cadmium plated pinion shafts supported on roller bearings. A mechanical seal will be provided around the pinion shaft where it extends from the bevel box enclosure.

11. Chain and sprocket systems with cage enclosures shall be acceptable.

12. A dual stem and interconnected operator system shall be provided when the opening width of the gate exceeds 60".

13. All gate material shall conform to the following:

   (a) Frames and Slides:

   1. Aluminum - ASTM B-209 & ASTM B-221 Alloy 6061-T6

   (b) Rails and Yokes:

   1. Aluminum - ASTM B-209 & ASTM B-221 Alloy 6061-T6, or
   2. Aluminum - ASTM B-221 Alloy 6063-T5

   (c) Fasteners and Anchor Bolts:
DUNDEE STATE FISH HATCHERY OZONE SYSTEM
PROJECT NUMBER 128632

1. Stainless steel - ASTM A-193, 18-8 or
2. Stainless steel - ASTM A-276 Type 304 or 316

(d) Stems:
1. Stainless steel - ASTM A-276 Type 303, 304, or 316

(e) Flush Bottom Seals and "J" Bulb Seals:
1. Rubber - ASTM D-2000 BC610-615 or other suitable composition for extended use in water and sewage.

K. Sluice Gates:
1. Gates shall be flanged mounted, self-contained with yoke and bench stand operators and rising stem extensions. The cover shall have horizontal and vertical stiffening ribs to withstand a maximum seating head of 50 feet. The frame and cover shall be cast iron per ASTM A126 Class B with bronze seating faces. The rails and yoke shall be Type 304 stainless steel. The stem shall be Type 304 stainless steel. All hardware and anchors and fasteners shall be stainless steel.

2. The frame and cover shall be cast iron with machined seating faces. Guide rails and head rails shall be a minimum of ¼-inch thick stainless steel, designed and built to withstand the total thrust of the gate slide due to water pressure and wedge action. There shall be adjustable wedges to ensure proper seating. Frame wedges shall be attached to the guide rails with two bolts. Wedges shall have a smooth bearing surface and shall be adjustable.

3. The stem shall be 304 stainless steel with a diameter capable of withstand ing 2 times the rated output of the operator at 40 pounds of pull and shall be supported so that the I/r ratio for the unsupported portion of the stem does not exceed 200.

4. Each sluice gate shall include a 4:1 geared operator.

5. Sluice gates shall be Waterman Industries Series 3000 medium duty gates with Type 3EN-4:1 geared operator or Engineer approved equal.

L. Slanting Disc Check Valves
1. The body shall be heavy, two-piece cast iron, not fabricated steel. The two body halves and body seat shall be O-ring sealed and bolted together in a manner to sandwich the body seat on a 55° angle. Each body half must have an access covered hole for internal inspection and each body half and disc fully machined to accept future attachments of a Bottom Buffer or Top Mounted Oil Dashpot. the seat ring and disc ring must be of the design that permits replaceability in the field without need for special tools or machining. The pivot pins in the body and the
bushings in the disc lugs must be stainless steel, but of different hardness to prevent galling. The bushings shall be press fit to prevent wear. An indicator shall be provided to show the position of the disc. The area throughout the valve body must be equal to full pipe area. The area throughout the seat section shall be 40% larger than the inlet and outlet of the valve to achieve lowest head loss. Valve materials shall be certified conforming to the following ASTM specifications:

<table>
<thead>
<tr>
<th>Part</th>
<th>Material</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bodies</td>
<td>Cast Iron</td>
<td>ASTM A126 GR. B</td>
</tr>
<tr>
<td>Disc (2&quot; through 10&quot;)</td>
<td>Bronze</td>
<td>ASTM B584 C83600</td>
</tr>
<tr>
<td>Disc (12&quot; &amp; larger)</td>
<td>Ductile Iron</td>
<td>ASTM A536</td>
</tr>
<tr>
<td>Seat Ring &amp; Disc Ring</td>
<td>Bronze</td>
<td>ASTM B271 C92200</td>
</tr>
<tr>
<td>Pivot Pins (2&quot; – 10&quot;)</td>
<td>Aluminum Bronze</td>
<td>ASTM B150 Alloy 2</td>
</tr>
<tr>
<td>Pivot Pins (12&quot; &amp; larger)</td>
<td>Stainless Steel</td>
<td>ASTM A582 T303</td>
</tr>
<tr>
<td>Pivot Pin Bushings</td>
<td>Stainless Steel</td>
<td>ASTM A269 T304</td>
</tr>
<tr>
<td>Exterior Paint</td>
<td>Primer Red Oxide</td>
<td>FDA Approved for Potable Water Contact</td>
</tr>
</tbody>
</table>

2. Valve to be APCO Series 800 Slanting Disc Check Valve as manufactured by Valve & Primer Corporation or engineer approved equal.

3. Top Mounted Dashpot: For slow open and non-slam closing, dashpot must have two (2) control closing flow rates:
   a. 90% rapid rate
   b. 10% slow rate during shut-down

4. Each rate shall be independently adjustable. The dashpot must be a self-contained oil system, separate and independent from the water line media. The oil reservoir for closing cycle shall be open to atmosphere with an air breather cap to prevent dust and other media from contaminating the oil. The oil reservoir for opening cycle must be hermetically sealed to contain pressure if necessary (air over oil) and be equipped with a pressure gauge and pneumatic air valve.

M. Telescoping Valves

1. The body shall be commercial brass. The lifting strap shall be stainless steel ASTM A-276. The retainer flange shall be cast iron ASTM A-126 Class B. The wiper gasket shall be neoprene ASTM D-2000. The rising stem and thrust nut shall be stainless steel ASTM A-276. The cotter pin shall be stainless steel. The hex bolt and nut shall be stainless steel ASTM F-593. The standard operator shall be mounted on an upright pedestal. Position indicators shall be furnished. The valve shall be Waterman Model TS-2 or engineer approved equal.

N. Mud Valves
1. The valve shall be of the heavy-duty flange type with non-rising stems as shown on the plans. The seats shall be bronze ASTM B-584 Alloy 844. The body shall be cast iron. The stems shall be stainless steel, non-rising. The lift nuts shall be bronze. The valve shall have stem extensions with adjustment nut and box with cover as shown on the plans. The valve shall be Waterman Model MV-11 or engineer approved equal.

O. Combination Air Valve/Vacuum Release Valve

1. The valve shall be a heavy-duty flange type valve. The body of the valve shall be cast iron and consist of a stainless steel float. The float shall be hermetically sealed, designed to withstand a minimum of 1000 psi. The top plug shall be brass and shall be center guided through hex bushings for positive shut-off. The bushings shall be seat shall be Buna-N.

2. Valve to shall APCO Series 140C Combination Air Valve/Vacuum Release Valve as manufactured by Valve & Primer Corporation or engineer approved equal.

P. Globe Surge Relief Valve

1. The valve shall be heavily constructed of cast iron valve body with integral end flange and full unobstructed flow through area. The disc shall be cast iron having a replaceable resilient Buna-N seat for tight shut-off. The pivot shaft shall be type 303 stainless steel and be a single unit, extending through the valve body with a weight and lever mounted on one or both ends. A heavy duty oil dashpot system shall be externally mounted on the valve to control the rate of closure to positively prevent any slam. The oil shall be stored in a stainless steel reservoir maintaining a constant head on the dashpot to immediately fill the dashpot with the valve opens. The valve shall be adjusted at the factory to hold closed against normal operating system pressures.

2. Valve to shall APCO Series 6500 Globe Surge Relief Valve as manufactured by Valve & Primer Corporation or engineer approved equal.

Q. Backflow Preventer

1. Double check with isolation gate valves, Ames 200 DCA or approved equal.

R. Valve Boxes

1. Valves buried in the ground shall be provided with cast iron valve boxes of proper dimensions to fit over the valve bonnets and to extend to such elevation at or slightly above the finished ground line, as directed by the Engineer. Tops shall be complete with covers and shall be adjustable. Valve boxes shall be set vertical and concentric with the valve stem.
2. Any valve box which has so moved from its original position as to prevent the application of the valve key shall be satisfactorily reset by the Contractor at his own expense. A concrete pad 1'6" x 1'6" x 4" thick shall be poured around all valve boxes. Extension stems shall be provided and installed for all valves with 2" square nut operators so that operating nut is within 3 ft. of ground surface.

S. FREEZE PROTECTION

1. Where specified on the plans, exposed piping, valves, or equipment shall be provided with freeze protection. The freeze protection shall consist of copper sheath, resistance type heating cable and 1" of insulation. The heating cable shall be designed to keep the contained fluid 50 degree F above ambient temperature. The heating cable shall be suitable for 110 V, single phase operation and ON-OFF switches for the tape shall be provided at each area of piping or equipment. The insulation shall be as specified except that preformed insulation must be oversized to allow for the heating cable.

T. COATINGS AND LININGS

1. General: Coatings and linings are specified on the piping system specifications sheets and shall conform to this section.

2. Galvanizing: Galvanizing shall be in accordance with ASTM A-153.

U. PIPE SUPPORTS

1. All exposed piping shall be supported in conformance with the pipe support and structural attachment details of this section.

V. PIPE INSULATION

1. For all exterior exposed piping less than 30 inches in diameter, above-ground outdoor piping shall be insulated with 2" J-M650 Micro-lok fiberglass pipe insulation material or equal. This material shall be covered with ASJ and stapled into place with outward clinching staples 2" O.C. Fittings and valves shall be covered with the same material and sealed with Childers CP-11 weatherproofing. All insulation shall be weatherproofed with a jacket of 0.016" smooth aluminum held in place with stainless steel screws 6" O.C. Fittings shall be weatherproofed with pre-molded PABCD fitting covers or equal.

2. Valve insulation shall be constructed with removable and replaceable panels for access to all adjustments and/or inspection points without damage to insulation.

W. JOINT RESTRAINT
1. Where thrust rod anchors are shown or specified the Star Joint Restraint System as manufactured by Star National Products of Columbus, Ohio shall be utilized. This system consists of the use of Super Star Tiebolts, Tienuts, Tierods (¾") and Tie couplings. The number of tierods required is listed as follows:

<table>
<thead>
<tr>
<th>Pipe Size (in.)</th>
<th>Number of 3/4&quot; Rods Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>12</td>
<td>4</td>
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<td>14</td>
<td>4</td>
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<td>16</td>
<td>6</td>
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<tr>
<td>18</td>
<td>6</td>
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<tr>
<td>20</td>
<td>8</td>
</tr>
<tr>
<td>24</td>
<td>10</td>
</tr>
<tr>
<td>30</td>
<td>12</td>
</tr>
</tbody>
</table>

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify building and trench backfilling have been inspected.
B. Verify substrate base has been contoured and compacted.

3.2 SUBSTRATE PREPARATION

A. Eliminate uneven areas and low spots.
B. Remove debris, roots, branches, stones, in excess of 1 inch in size. Remove subsoil contaminated with petroleum products.
C. Scarify surface to depth of 4 inches where topsoil is scheduled. Scarify in areas where equipment used for hauling and spreading topsoil has compacted subsoil.

3.3 PLACING TOPSOIL

A. Place topsoil in areas where seeding, sodding, and planting is required, to thickness as scheduled. Place topsoil during dry weather.
B. Fine grade topsoil to eliminate rough or low areas. Maintain profiles and contour of subgrade.
C. Remove roots, weeds, rocks, and foreign material while spreading.

D. Manually spread topsoil close to plant life, buildings, and structures to prevent damage.

E. Lightly compact placed topsoil.

F. Remove surplus subsoil and topsoil from site.

G. Leave stockpile area and site clean and raked, ready to receive landscaping.

3.4 TOLERANCES

A. Top of Topsoil: Plus or minus ½ inch.

3.5 PROTECTION

A. Protect landscaping and other features remaining as final work.

B. Protect existing structures, fences, sidewalks, utilities, paving, and curbs.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES

A. The work to be performed under this section of the Specifications shall include:

1. Furnishing and installation of EIM Electric Actuators for valves specified and shown.

2. Furnishing and installation of all necessary bracket, bearings, bushings, attachments and necessary appurtenances required for proper and intended operation.

1.2 RELATED SECTIONS

A. UGC Article 8 – Quality Control; Submittals

B. Section 02669 – Valves and Couplings.

1.3 SUBMITTALS

A. Submittals shall be made as soon as feasible after award of the Contract, and in any event, shall be submitted and approval obtained before beginning installation of the equipment. The Contractor shall furnish the Engineer with six copies of the submission.

B. The information required on the submittals shall include, but not necessarily be limited to the following:

1. Full and complete specifications covering the equipment proposed to be furnished.

2. Catalog cut sheets clearly marked to indicate the model number of each proposed item/assembly, its dimensions, materials of construction, operating pressures, torque output, weight, power requirements, input and output signal types and any other characterizing information.

3. Shop drawing of each proposed bracket and coupling to include dimensions, materials of construction, type of finish and designation as to the particular valve/actuator combination for which it is intended.
4. Written certification that the retrofitting and/or automation shall be performed by the regional authorized actuator representative.

5. Such weights of the equipment as necessary including the heaviest piece to be handled during construction.

6. Nearest location of factory maintenance and service facilities that will be available to service the equipment offered.

1.4 QUALITY CONTROL

A. UGC Article 8 – Quality Control

PART 2 PRODUCTS

2.1 QUARTER TURN ELECTRIC ACTUATORS:

A. General: This specification is for electric actuators fitted with Open/Close position limit switches. Open/Close torque switches, and a basic integral control package comprising reversing contactors and internal control transformer, with a local control station, advanced electronic control functions, and manual gear actuator override. Electric actuators shall be provided for butterfly valve operation suitable for outdoor exterior exposed operation. Electric actuators shall be EIM Company, Missouri City, Texas Series 2000/M2CP or Engineer approved equal.

B. Motor: Actuators driven by a high torque, low inertia electric motor rated for 15 minute duty for On/Off applications shall be standard. All motors are totally enclosed, non-ventilated NEMA 4 type with Class "F" insulation and have thermostats embedded in the windings for thermal overload protection.

C. Electrical Compartment: The transformer, reversing contactors, power module, terminal board module, overload relay, intermediate switch module, limit switch module, LEDs, torque switch, anti-condensation heater, and terminals shall be located in one central NEMA 4 compartment which is "O"-ring sealed and easily accessible. An earth/ground terminal shall included.

D. Reversing Contactors: A set of reversing contactors, mechanically and electrically interlocked shall be provided.

E. Transformer: A control transformer, with 110VAC output, shall be provided to power the contactor coils.

F. Torque Switch: A torque switch shall be provided for control and protection in both the Open and Close directions, with one normally closed contact for each direction. The
torque switch shall be adjustable and a limit plate is fitted in order that the torque setting cannot be increased above the rating of the actuator or motor.

G. Intermediate Switch Module: For all modulating valve actuators, the intermediate switch module shall be Futronic II position control.

H. Manual Operation: All actuators shall be provided with a handwheel for manual operation. The de-clutching mechanism shall be designed so that motor operation always has priority over manual operation. Whenever the motor is started, the hand mechanism will disengage automatically without endangering the operator. The de-clutch lever shall be padlockable in the motor mode to prevent unauthorized manual operation.

I. Lubrication: Actuators shall be grease-filled prior to dispatch from the factory and, apart from periodic inspection, no lubrication is necessary.

J. Power Supply: See schedule


L. Position Indication: A local mechanical position indicator, showing Open/Intermediate/Close valve position shall be included.

M. Extra Torque Switches (DPDT): An additional SPDT contact is provided in each direction to give an indication of overtorque condition when the set torque is exceeded.

N. Disconnect Switch: Disconnect devise shall be mounted in the electrical compartment. External door interlocks shall require disconnect to be engaged before opening electrical compartment.

O. Local Control Station: A local control station will be incorporated, with three (3) pushbuttons for Open/Stop/Close function, two (2) indicating lights for open/close Indication.

P. All electric actuators shall be warranted for a period of three years from date of final completion, said warranty to cover 100% parts and labor as well as performance in the application.

PART 3 EXECUTION

3.1 ACTUATOR MOUNTING RESPONSIBILITY

A. Valves to be actuated shall be shipped to the Valve Automation Fabricator (see AWWA, C-504-94, Section 1.6, Assembly). All new valves to be automated using electric actuators are to be sent to the respective regional authorized actuator representative for complete assembly, calibration and testing in order to validate the three (3) year warranty.
A certificate attesting to the calibration, testing and warranty shall be included in the final O & M manual.

3.2 OPERATION AND MAINTENANCE MANUALS

A. Provide six operation and maintenance manuals.

3.3 WARRANTY

A. The actuator manufacturer shall guarantee for three years from the date of the Certificate of Final Completion that the equipment will be free from defects of all kinds including application, design, materials, and workmanship. A full written parts and service type warranty shall be provided for this three year time period.

3.4 START-UP AND TRAINING

A. The supplier of the valve actuators shall provide a factory-trained technician for one day to supervise installation and start-up as required at no additional cost. On completion of start-up, a certificate shall be provided by the valve actuator supplier indicating that proper installation and start-up procedures have been followed. This certificate shall be included as part of the final operation and maintenance manuals and shall be required in order to validate the specified three year warranty.

3.5 SCHEDULE

A. Electric Actuators:

1. Dundee State Fish Hatchery Ozone System:

   a. FV-904, Bypass Line Valve (Open/Close, Fail Open) – 460V, 3-phase. Valve shall be provided with a response time of 30 seconds, fully open to fully closed.

   b. LV-1101, Contact Tank Level Control Valve (Modulating, Fail Closed) – 460V, 3-phase. Valve shall be provided with a response time of 30 seconds, fully open to fully closed.

   c. FV-1102, Contact Tank Flow Control Valve (Modulating, Fail Closed) – 460V, 3-phase. Valve shall be provided with a response time of 30 seconds, fully open to fully closed.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES

A. Fence framework, fabric, and accessories.

B. Excavation for post bases; concrete foundation for posts.

1.2 RELATED SECTIONS

A. Section 03305 Concrete

1.3 REFERENCES

A. ASTM A121 - Zinc-Coated (Galvanized) Steel Barbed Wire.


C. ASTM A153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

D. ASTM A392 - Zinc-Coated Steel Chain-Link Fence Fabric.

E. ASTM A428 - Weight of Coating on Aluminum-Coated Iron or Steel Articles.

F. ASTM A446 - Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality.

G. ASTM A569 - Steel, Carbon (0.15 Maximum Percent), Hot-Rolled Sheet and Strip Commercial Quality.

H. ASTM C94 - Ready-mixed Concrete.

I. ASTM F567 - Installation of Chain-Link Fence.

J. ASTM F669 - Strength Requirements of Metal Posts and Rails for Industrial Chain Link Fence.

K. ASTM F1083 - Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.

L. ASTM F1234 - Protective Coatings on Steel Framework for Fences.
1.4 SUMMARY OF WORK

A. Fences and gates shall be provided and installed in locations of existing fences which may be damaged or removed during construction of the project. Removal and replacement of fence shall be considered subsidiary to the various work items unless specifically shown in the bid proposal.

B. Existing fences shall be replaced in kind with new posts, fabric, wire, and supports to match existing fence. Contractor shall secure new fencing to existing fencing that remains such that there are no gaps or holes in the fence.

1.5 SUBMITTALS FOR REVIEW

A. Product Data: Provide data on gates, fabric, posts, accessories, fittings and hardware.

B. Shop Drawings: Indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, and schedule of components.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with manufacturer’s instructions.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the products specified in this section with minimum five (5) years documented experience.

PART 2 PRODUCTS

2.1 MATERIALS

A. Framing (Steel): ASTM A569; hot rolled steel strip, cold formed to pipe configuration, longitudinally welded construction, minimum yield strength of 50 ksi; coating conforming to ASTM F1234 Type B on pipe exterior and interior.


C. Barbed Wire: ASTM A121 galvanized steel; 12 gauge thick wire, 3 strands, 4 points at 3 inch on center.

D. Concrete: Type specified in Section 03305 Concrete.
2.2 COMPONENTS

A. Chain Link Fence

1. Line Posts: 2" outside diameter steel pipe.
2. Corner and Terminal Posts: 3" outside diameter steel post.
3. Gate Posts: 4" outside diameter steel pipe.
4. Pedestrian Gate Posts: 2" outside diameter steel pipe.
5. Top and Brace Rail: 1" outside diameter, plain end, sleeve coupled.
6. Gate Frame and Tail: 2" outside diameter for fittings and truss rod fabrication.
7. Steel Tube Gate: 2 inch x 2 inch square tube steel.
8. Fabric: 2 inch diamond mesh interwoven wire, 9 gauge thick, top salvage knuckle end closed, bottom selvage knuckle end closed.
10. Tension Band: 1 inch thick steel.
11. Tension Bar: 2 inch outside diameter thick steel.

B. Barbed Wire and Field Fence

1. Barbed wire shall be 12½ gauge, 2-point, round barb, American made.
2. Steel “T” posts shall be 6½ feet long, No. 1 American made with plate. Posts shall be painted and spaced no greater than 10 feet. Install posts to minimum of one foot below grade, plumb, and in line with fence row. Provide clips for attaching barbed wire to post.
3. Corner posts and bracing shall be 3-inch diameter steel pipe set in concrete with 3-inch bracing post in concrete at a maximum of 8 feet in each direction. Brace posts shall be connected with a minimum of three 1½” diameter tie rods welded to the brace posts and the corner posts. Corner and brace posts shall be set to a minimum of three feet below grade. Install corner and brace posts plumb and in line with fence row.

C. Game Fence
1. Game fence wire fabric shall be a nominal 8-ft, fixed-knot game fence with 20 horizontal wires, with horizontal openings of 6-3", 2-4", 2-5", 3-6", and 6-7" and a 6" horizontal spacing between the vertical stay wires shall be used.

2. Line post shall be 2.375" diameter steel pipe installed every 125' (max).

3. Tee post shall be 1.5 lb/ft steel installed very 25' (max).

D. Tubular Gates - Gate posts shall be 4" diameter steel posts set in concrete. Gate posts shall be set to a minimum of three feet below grade. Tubular gate shall be constructed of 2" square tube steel.

2.3 ACCESSORIES

A. Gate Caps: Cast steel galvanized; finish as determined by Owner.

B. Fence Caps: Cast steel galvanized; sized to post diameter, set screw retainer.

C. Fittings: Sleeves, bands, clips, rail ends, tension bars, fasteners and fittings; steel.

D. Extension Arms: Cast steel galvanized, to accommodate 3 strands of barbed wire, single arm, sloped to 45 degrees.

E. Laminated Steel Padlock with Grade 30, ¼" Galvanized Steel Chain: Masterlock Model No. 5KA-A326. All locks shall be master keyed with the City.

2.4 FINISHES

A. Components and Fabric: Galvanized to ASTM A123; 2.0 oz/sf coating.

B. Hardware: Galvanized to ASTM A153, 2.0 oz/sf coating.

C. Accessories: Same finish as framing.

PART 3 EXECUTION

3.1 INSTALLATION

A. Post Setting

1. Install framework, fabric barbed wire, accessories and gates in accordance with ASTM F567 and manufacturer's instructions.
2. Set all vertical posts plumb, in concrete footings with top of footing 2 inches above finish grade. Slope top of concrete for water runoff.

3. Line Post Footing Depth Below Finish Grade: ASTM F567 3 feet.

4. Corner, Gate and Terminal Post Footing Depth Below Finish Grade: ASTM F567 3 feet.

5. Brace each gate and corner post to adjacent line post with horizontal center brace rail and diagonal truss rods. Install brace rail one bay from end and gate posts.

B. Chain Link Fabric

1. Provide top rail through line post tops and shall be continuous.

2. Do not stretch fabric until concrete foundation has cured 7 days.

3. Stretch fabric between terminal posts or at intervals of 100 feet maximum, whichever is less.

4. Position bottom of fabric no less than 1 inch, no more than 4 inches above finished grade.

5. Fasten fabric to top rail, line posts, braces, and bottom tension wire with tie wire at maximum 15 inches on centers.

6. Attach fabric to end, corner, and gate posts with tension bars and tension bar clips.

7. Install support arms sloped outward and attach barbed wire; tension and secure.

8. Install support arms sloped outward and attach barbed wire; tension and secure.

C. Barbed Wire

1. Barbed-wire shall be attached to gate corner pull and terminal post by a band clip. The wire shall be stretched taut before fastening.

2. Tie wires, bolts, tension wire, and other fastening shall be properly tightened. Erection shall provide a fence firmly secured in proper position.

D. Game Fence

1. Do not stretch fabric until concrete foundation has cured 7 days.
2. Stretch fabric between terminal posts or at intervals of 100 feet maximum, whichever is less.

3. Position bottom of fabric no less than 1 inch, no more than 4 inches above finished grade.

4. Fasten fabric to top rail, line posts, braces, and bottom tension wire with tie wire at maximum 15 inches on centers.

5. Attach fabric to end, corner, and gate posts with tension bars and tension bar clips.

6. Install support arms sloped outward and attach barbed wire; tension and secure.

7. Install support arms sloped outward and attach barbed wire; tension and secure.

3.2 ERECTION TOLERANCES

A. Maximum Variation From Plumb: ¼ inch.

B. Maximum Offset From True Position: 1 inch.

C. Components shall not infringe adjacent property lines.

END OF SECTION
DUNDEE STATE FISH HATCHERY OZONE SYSTEM
PROJECT NUMBER 128632

SECTION 02923

LANDSCAPE GRADING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Final grade topsoil for finish landscaping.

1.2 RELATED SECTIONS

A. UGC Article 8 - Quality Control
B. Section 02205 - Soil Materials.
C. Section 02225 - Excavation, Backfilling and Compacting for Utilities

PART 2 PRODUCTS

2.1 MATERIAL

A. Topsoil: Fill Type S4 as specified in Section 02205.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify building and trench backfilling have been inspected.
B. Verify substrate base has been contoured and compacted.

3.2 SUBSTRATE PREPARATION

A. Eliminate uneven areas and low spots.
B. Remove debris, roots, branches, stones, in excess of 1 inch in size. Remove subsoil contaminated with petroleum products.
C. Scarify surface to depth of 4 inches where topsoil is scheduled. Scarify in areas where equipment used for hauling and spreading topsoil has compacted subsoil.

3.3 PLACING TOPSOIL

A. Place topsoil in areas where seeding, sodding, and planting is required, to thickness as scheduled. Place topsoil during dry weather.
B. Fine grade topsoil to eliminate rough or low areas. Maintain profiles and contour of subgrade.
C. Remove roots, weeds, rocks, and foreign material while spreading.
D. Manually spread topsoil close to plant life, buildings, and structures to prevent damage.
E. Lightly compact placed topsoil.
F. Remove surplus subsoil and topsoil from site.
G. Leave stockpile area and site clean and raked, ready to receive landscaping.

3.4 TOLERANCES
   A. Top of Topsoil: Plus or minus ½ inch.

3.5 PROTECTION
   A. Protect landscaping and other features remaining as final work.
   B. Protect existing structures, fences, utilities, paving, and curbs.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES

A. Preparation of subsoil.

B. Placing topsoil.

C. Temporary Cool Weather Seed Mixture (For Installation if Requested By Engineer).

D. Seeding, Hydroseeding, mulching, and fertilizer.

1.2 RELATED SECTIONS

A. Section 02205 - Soil Materials: Topsoil material.

B. Section 02923 - Landscape Grading: Preparation of subsoil and placement of topsoil in preparation for the work of this Section.

1.3 REFERENCES

A. FS O-F-241 - Fertilizers, Mixed, Commercial.

B. Texas Seed Law.

1.4 DEFINITIONS


1.5 QUALITY ASSURANCE

A. Provide seed mixture in containers showing percentage of seed mix, year of production, net weight, date of packaging, and location of packaging.

B. All seed shall be labeled in accordance with the current rules and regulations of the Texas Seed Law and shall be free of noxious weeds as listed by the Board.

C. All legumes must be inoculated with an approved culture as per the manufacturer’s recommendations.

1.6 REGULATORY REQUIREMENTS
A. Comply with all regulatory agencies for fertilizer and herbicide composition.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver grass seed mixture in sealed containers unless otherwise authorized by the Engineer in writing. Seed in damaged packaging is not acceptable.

B. Seed, which has become wet, moldy, or otherwise damaged in transit or storage will not be acceptable.

C. Deliver fertilized in waterproof bags showing weight, chemical analysis, and name of manufacturer.

PART 2 PRODUCTS

2.1 SEED MIXTURE

A. Normal Application Seed Mixture (For installation on slopes between 5:1 and 6:1 inclusive, unless otherwise approved by the Engineer)

<table>
<thead>
<tr>
<th>Species</th>
<th>Single Species Rate</th>
<th>% of Mix</th>
<th>(PLS-#/ Acre Mix)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sideoats grama (El Reno)</td>
<td>6</td>
<td>25</td>
<td>1.5</td>
</tr>
<tr>
<td>Blue grama (Hatchita)</td>
<td>1 (3)</td>
<td>25</td>
<td>0.5</td>
</tr>
<tr>
<td>Buffalograss (Texoka) (Treated seed)</td>
<td>10 (20)</td>
<td>25</td>
<td>5.0</td>
</tr>
<tr>
<td>Little Bluestem (OK Select)</td>
<td>4.5</td>
<td>15</td>
<td>0.7</td>
</tr>
<tr>
<td>Sand Bluestem (Woodward)</td>
<td>6 (12)</td>
<td>10</td>
<td>1.0</td>
</tr>
</tbody>
</table>

B. Temporary Cool Weather Seeding

<table>
<thead>
<tr>
<th>Species</th>
<th>Single Species Rate</th>
<th>% of Mix</th>
<th>(PLS-#/ Acre Mix)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Western Wheatgrass</td>
<td>8 (12)</td>
<td>100</td>
<td>12</td>
</tr>
</tbody>
</table>

1. If required, temporary seeding shall be installed using a drill seeder without fertilizer.
2. If temporary seeding is required, the contractor will be required to disc and drag the topsoil to remove the temporary vegetation prior to the installation of the normal seed mixture.

3. The price for diskimg, dragging, and removing the temporary vegetation shall be included in the price of the Temporary Cool Weather Seeding.

2.2 SOIL MATERIALS

A. Topsoil: As specified in Section 02205.

2.3 ACCESSORIES

A. Liquid Lime:

1. Liming will be required for all area when the normal seed mixtures are applied.

2. The lime to be used shall be liquid lime and shall be applied at a rate of 5 gallons per acre.

3. The liquid lime shall be flowable dolomitic limestone ground to a fineness whereby 100% will pass through a 300-mesh screen.

4. The liquid lime shall be as distributed by Southwest Environment Services, Inc. of Tyler, Texas or approved equal.

5. The liquid lime shall be applied at the same time as the seed and fertilizer with the use of a hydroseeder.

B. Mulching Material: Oat or wheat straw, free from weeds, foreign matter detrimental to plant life, and dry. Chopped cornstalks are acceptable.

C. Plaster/cellulose Fiber Mulch:

1. Plaster/cellulose fiber mulch shall be a mixture of plaster and natural cellulose fiber mulch.

2. The plaster shall consist of naturally-occurring high purity processed gypsum and necessary additives, such as retarders and accelerators and water to form a cementitious binder that will produce a protective crust-like barrier within 4 to 8 hours after application.

3. The gypsum shall be produced from a quarried or mined source.
4. In addition, the gypsum shall be processed to be composed of a crushed, dry calcium sulfate hemihydrate (\( \text{CaSO}_4 \cdot \frac{1}{2} \text{H}_2\text{O} \)) having a purity of not less than 88%.

5. The processed gypsum plus the necessary additives shall be furnished in bags or bulk and be accompanied by bills of landing and shipping invoices stating the gypsum purity content, dry weight, and source of manufacture.

6. Processed gypsum, which has become partially air set, lumpy, or caked prior to use will be rejected.

7. The cellulose fiber mulch shall be produced from grinding clean, whole wood chips, or fiber produced from ground newsprint with a labeled ash content not to exceed 7%.

D. Fertilizer:

1. FS O-F-241, Type I, Grade A; recommended for grass, with fifty percent of the elements derived from organic sources; of proportion necessary to eliminate any deficiencies of topsoil to the following proportions:

2. The contractor shall have a turf analysis performed for the topsoil (4 maximum).

3. Based upon the results of the turf analysis, the following fertilizer requirement may be adjusted to suit the existing topsoil.

   a. Fertilizer shall be thirty percent (30%) nitrogen, thirty percent (30%) phosphorous, and thirty percent (30%) potash commercial fertilizer and shall be spread at the minimum rate of 650 lbs. per acre.

   b. In addition, trace elements such as K-Mag may be required if the need is shown by the turn analysis.

E. Water:

1. Clean, fresh and free of substances or matter, which could inhibit vigorous growth of grass.

2. The Contractor shall water the seed and sprigs and add fertilizer as he deems necessary to establish the grass, at no expense to the Owner.

F. Prevent contamination.

PART 3 EXECUTION

3.1 EXAMINATION
A. Verify that prepared soil base is ready to receive the work of this Section.

3.2 PREPARATION OF SUBSOIL

A. Prepare sub-soil to eliminate uneven areas and low spots. Maintain lines, levels, profiles and contours. Make changes in grade gradual. Blend slopes into level areas.

B. Remove foreign materials, weeds and undesirable plants and their roots. Remove contaminated sub-soil.

C. Scarify subsoil to a depth of 4 inches where topsoil is to be placed. Repeat cultivation in areas where equipment, used for hauling and spreading topsoil, has compacted sub-soil.

3.3 PLACING TOPSOIL

A. Spread topsoil to a minimum depth of 4 inches over area to be seeded. Rake until smooth.

B. Place topsoil during dry weather and on dry unfrozen subgrade.

C. Remove vegetable matter and foreign non-organic material from topsoil while spreading.

D. Grade topsoil to eliminate rough, low or soft areas, and to ensure positive drainage.

E. Install edging at periphery of seeded areas in straight lines to consistent depth.

3.4 FERTILIZING

A. Apply fertilizer in accordance with manufacturer's instructions.

B. Apply after smooth raking of topsoil and prior to roller compaction.

C. For dry placing do not apply fertilizer at same time or with same machine as will be used to apply seed.

D. Lightly water to aid the dissipation of fertilizer.

3.5 HYDROSEEDING

A. Apply seeded slurry with a hydraulic seeder at a rate of 5 pounds per 1000 square feet evenly in two intersecting directions.

B. Do not hydroseed area in excess of that which can be mulched on same day.

C. Immediately following seeding, apply mulch to a thickness of \( \frac{1}{8} \) inches. Maintain clear of shrubs and trees.

D. Apply water with a fine spray immediately after each area has been mulched. Saturate to 3 inches of soil.
3.6 SCHEDULE

A. Hydroseed and Mulch all disturbed areas with normal seed mixture.

END OF SECTION
DIVISION 03000
CONCRETE
PART 1 GENERAL

1.1 SECTION INCLUDES

A. Formwork for cast-in-place concrete, with shoring, bracing and anchorage.
B. Openings for other work.
C. Form accessories.
D. Form stripping.

1.2 RELATED SECTIONS

A. Section 03200 - Concrete Reinforcement.
B. Section 03305 - Cast-in-Place Concrete.

1.3 REFERENCES

A. ACI 117 – Tolerances for Construction and Materials
B. ACI 301 - Structural Concrete for Buildings.
C. ACI 318 - Building Code Requirements for Reinforced Concrete.
D. ACI 347 - Recommended Practice For Concrete Formwork.
E. PS 1 - Construction and Industrial Plywood.

1.4 DESIGN REQUIREMENTS

A. Design, engineer and construct formwork, shoring and bracing to conform to design and code requirements; resultant concrete to conform to required shape, line and dimension.

1.5 SUBMITTALS

A. Submit under provisions of UGC Article 8 – Quality Control; Submittals.
B. Shop Drawings: Indicate pertinent dimensions, materials, bracing, and arrangement of joints and ties.
C. Product Data: Provide data on void form materials and installation requirements.

1.6 QUALITY ASSURANCE:

A. Perform Work in accordance with ACI 347, 301, 318.
1.7 REGULATORY REQUIREMENTS:
A. Conform to applicable code for design, fabrication, erection and removal of formwork.

1.8 FIELD SAMPLES:
A. Provide under provisions of UGC Article 8 – Quality Control; Submittals.
B. Coordinate with requirements stated in Section 03100 and 03305.

1.9 DELIVERY, STORAGE, AND HANDLING
A. Deliver, store, protect and handle products to site under provisions of Special Conditions Paragraph 2.01 – Construction Materials.
B. Deliver void forms and installation instructions in manufacturer's packaging.
C. Store off ground in ventilated and protected manner to prevent deterioration from moisture.

1.10 COORDINATION
A. Coordinate work under provisions of Article 3 – General Responsibilities of Owner and Contractor.
B. Coordinate this Section with other Sections of work, which require attachment of components to formwork.
C. If formwork is placed after reinforcement resulting in insufficient concrete cover over reinforcement before proceeding, request instructions from Engineer.

PART 2 PRODUCTS

2.1 MATERIALS
A. Forms
1. Forms shall be of wood, metal, highly water resistant plywood, or other material approved by the Engineer.
2. Forms for sections greater than 18” thick shall be of wood.
3. Form surfaces shall be smooth and free from irregularities, dents, sags, or holes when used for permanently exposed surfaces.
4. Bolts and rods used for internal ties shall be so arranged that, when the forms are removed, all metal will not be less than 2” from any concrete surface.
5. Wire ties will not be permitted where concrete surface will be exposed to weathering, and discoloration would be objectionable.
6. Exposed concrete shall have approved form liners of masonite or plywood, or shall be constructed of smooth surfaced plywood.

7. Forms offsets for exposed concrete shall meet Class A requirements. All other form offsets shall meet Class C requirements.

B. Corner Forms

1. Corner forms forming 3/4” chamfers or as otherwise specified on plans, shall be used on all outside corners that are to be exposed in the finished structure.

2. Chamfer forms shall be molded plastic or polyvinyl chloride radius or chamfer strips. Use one style of form throughout the project.

C. Rustication and Score Line Strips

1. Rustication and score line strips shall be a non-absorbent material such as extruded polyvinyl chloride, plastic, fiberglass or metal or they may be milled from good quality lumber and well sealed to prevent moisture absorption.

2. Wood strips may not have protruding splinters, which may become embedded in the concrete.

3. Sealing wood shall be accomplished by immersion or brushing on two coats of form coating.

D. Form Ties

1. Form ties for concrete shall have an approved waterstop barrier to prevent seepage of moisture along the ties.

2. The ends of the tie metal after breaking off shall be minimum of 1 ½” from the finished wall face.

3. Submit samples to the Engineer for review.

PART 3 EXECUTION

3.1 EXAMINATION:

A. Verify lines, levels and centers before proceeding with formwork.

B. Ensure that dimensions agree with drawings.
3.2 ERECTION - FORMWORK

A. Erect formwork, shoring and bracing to achieve design requirements, in accordance with requirements of ACI 301.

B. Provide bracing to ensure stability of formwork. Shore or strengthen formwork subject to over stressing by construction loads.

C. Arrange and assemble formwork to permit dismantling and stripping. Do not damage concrete during stripping. Permit removal of remaining principal shores.

D. Align joints and make watertight. Keep form joints to a minimum.

E. Obtain approval before framing openings in structural members, which are not indicated on Drawings.

F. Provide fillet and chamfer strips on external corners of beams, joists, and columns.

G. Install void forms in accordance with manufacturer's recommendations. Protect forms from moisture or crushing.

3.3 APPLICATION - FORM RELEASE AGENT

A. Apply form release agent on formwork in accordance with manufacturer's recommendations.

B. Apply prior to placement of reinforcing steel, anchoring devices, and embedded items.

C. Do not apply form release agent where concrete surfaces will receive special finishes or applied coverings, which are effected by agent.

D. Soak inside surfaces of untreated forms with clean water.

E. Keep surfaces coated prior to placement of concrete.

3.4 INSERTS, EMBEDDED PARTS, AND OPENINGS

A. Provide formed openings where required for items to be embedded in passing through concrete work.

B. Locate and set in place items, which will be cast directly into concrete.

C. Coordinate with work of other sections in forming and placing openings, slots, reglets, recesses, sleeves, bolts, anchors, other inserts, and components of other Work.

D. Install accessories in accordance with manufacturer's instructions, straight, level, and plumb.

E. Ensure items are not disturbed during concrete placement.
F. Install waterstops continuous without displacing reinforcement.
G. Heat seal joints watertight.
H. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection.
I. Locate openings at bottom of forms to allow flushing water to drain.
J. Close temporary openings with tight fitting panels, flush with inside face of forms, and neatly fitted so joints will not be apparent in exposed concrete surfaces.

3.5 FORM CLEANING
A. Clean forms as erection proceeds, to remove foreign matter within forms.
B. Clean formed cavities of debris prior to placing concrete.
C. Flush with water or use compressed air to remove remaining foreign matter.
D. Ensure that water and debris drain to exterior through clean-out ports.
E. During cold weather, remove ice and snow from within forms.
F. Do not use de-icing salts.
G. Do not use water to clean out forms, unless formwork and concrete construction proceed within heated enclosure.
H. Use compressed air or other means to remove foreign matter.

3.6 FORMWORK TOLERANCES
A. Construct formwork to maintain tolerances required by ACI 301.
B. Camber slabs and beams 1/4 inch per 10 feet in accordance with ACI 301.

3.7 FIELD QUALITY CONTROL
A. Inspect erected formwork, shoring, and bracing to ensure that work is in accordance with formwork design, and that supports, fastenings, wedges, ties, and items are secure.
B. Do not reuse forms that are worn or damaged beyond repair. Do not patch formwork.

3.8 FORM REMOVAL
A. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads.
B. Loosen forms carefully. Do not wedge pry bars, hammers, or tools against finish concrete surfaces scheduled for exposure to view.
C. Store removed forms in manner that surfaces to be in contact with fresh concrete will not be damaged. Discard damaged forms.

D. Forms or shores for supported slabs and beams shall not be removed until the concrete, so supported, has acquired 70 percent of its design strength; except where loads other than the dead weight of the concrete are added, the shores shall not be removed until 24 hours after the concrete has obtained 90 percent of its design strength.

E. Forms shall be removed immediately after expiration of the lapsed time specified above or sooner, if required by the Engineer, where concrete is to receive a rubbed finish.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES

1.2 RELATED SECTIONS
A. Section 03100 - Concrete Formwork.
B. Section 03305 - Cast-in-Place Concrete.

1.3 REFERENCES
A. ACI 117 – Tolerances for Concrete Construction and Materials.
B. ACI 301 - Structural Concrete for Buildings.
C. ACI 318 - Building Code Requirements For Reinforced Concrete.
D. ACI SP-66 - American Concrete Institute - Detailing Manual.
E. ANSI/ASTM A82 - Cold Drawn Steel Wire for Concrete Reinforcement.
F. ANSI/ASTM A184 - Fabricated Deformed Steel Bar Mats for Concrete Reinforcement.
G. ANSI/ASTM A185 - Welded Steel Wire Fabric for Concrete Reinforcement.
H. ANSI/ASTM A496 - Deformed Steel Wire Fabric for Concrete Reinforcement.
I. ANSI/ASTM A497 - Welded Deformed Steel Wire Fabric for Concrete Reinforcement.
J. ANSI/AWS D1.4 - Structural Welding Code for Reinforcing Steel.
K. ASTM A615 - Deformed and Plain Billet Steel Bars for Concrete Reinforcement.
L. ASTM A767 - Zinc-Coated (Galvanized) Bars for Concrete Reinforcement.
M. ASTM A775 - Epoxy-Coated Reinforcing Steel Bars.
N. ASTM D3963 - Epoxy-Coated Reinforcing Steel.
O. AWS D12.1 - Welding Reinforcement Steel, Metal Inserts and Connections in Reinforced Concrete Construction.
P. CRSI - Concrete Reinforcing Steel Institute - Manual of Practice.
Q. CRSI - Placing Reinforcing Bars.

1.4 SUBMITTALS

A. Submit under provisions of UGC Article 8 – Quality Control; Submittals.
B. Shop Drawings:
   1. Indicate bar sizes, spacings, locations, and quantities of reinforcing steel and wire fabric, bending and cutting schedules, and supporting and spacing devices.
C. Manufacturer’s Certificate:
   1. Certify that products meet or exceed specified requirements.

1.5 QUALITY ASSURANCE

B. Submit certified copies of mill test report of reinforcement materials analysis.
C. Provide Engineer with access to fabrication plant to facilitate inspection of reinforcement.
D. Provide notification of commencement and duration of shop fabrication in sufficient time to allow inspection.
E. Store steel reinforcement above ground on platforms, skids or other supports.

1.6 QUALIFICATIONS

A. Design reinforcement under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in the State of Texas.
B. Welders’ Certificates:
   1. Submit under provisions of UGC Article 8 – Quality Control; Submittals Manufacturer’s Certificates, certifying welders employed on the Work, verifying AWS qualification within the previous 12 months.

1.7 COORDINATION

A. Coordinate work under provisions of Article 3 – General Responsibilities of Owner and Contractor.
B. Coordinate with placement of formwork, formed openings and other Work.

PART 2 PRODUCTS
2.1 REINFORCEMENT

A. Reinforcing Steel:
   1. ASTM A615, 60 yield grade; deformed billet steel bars. Ozone contact chamber reinforcing steel shall be epoxy coated.

B. Welded Steel Wire Fabric:
   1. ASTM A185 or ASTM A497 Deformed Type.

2.2 ACCESSORY MATERIALS

A. Tie Wire:
   1. Minimum 16 gage annealed steel.

B. Special Chairs, Bolsters, Bar Supports, Spacers Adjacent to Weather Exposed Concrete Surfaces: Plastic coated steel, Stainless steel type; size and shape as required.

2.3 FABRICATION


B. Reinforcement bars shall be bent cold to the shapes indicated on the Plans.

C. Fabrication tolerances, fabrication, and detailing of steel reinforcement shall conform to ACI – 315.

D. Steel reinforcement shall be of the type and size, cut to lengths and bent to shapes as indicated on the Plans.

E. Unless otherwise indicated, hooks, laps, splices, embedment lengths, and other details of reinforcement shall be provided as set forth in the ACI Building Code (ACI – 318) to develop the full tensile strength of the bar.

F. Welding may not be used except with the specific approval of the Engineer. Welding, when approved, shall conform to ANSI/AWS D12.1.

G. No splices of bars, except when shown on the Plans, will be permitted without the approval of the Engineer.

H. Welded wire fabric shall be lap spliced a minimum of 2” plus the bar spacing.

I. Splices in reinforcing bars shall conform to the general requirements of the ACI Code, except rung tension reinforcement splices, which should be a minimum of 40 bar diameters.

J. Splices should be staggered where possible or increase by 30 percent.
PART 3 EXECUTION

3.1 PLACEMENT

A. Place, support and secure reinforcement against displacement by ties of annealed wire, or suitable clips at intersections.
   1. Do not deviate from required position.
   2. Placing tolerances shall conform to ACI – 318.

B. Nails shall not be driven into the wall forms to support reinforcement nor shall any other device used for this purpose come in contact with the form on the waterside of any water containing structure.

C. Metal devices used to provide the required clear distances from reinforcing steel to waterside of concrete surfaces shall be galvanized, or shall be as approved by the Engineer.

D. The main reinforcement of slabs in contact with the ground shall be supported in its proper position, as indicated on Plans, by means of precast cement mortar blocks (composed of one part cement to two parts sand), of approved dimensions, resting on the slabs’ sub-base.

E. The slab reinforcement shall not be used to support planking or runways used in placing concrete.

F. Bending of bars embedded in hardened concrete will not be permitted except when specifically approved by the Engineer for the field condition encountered.

G. Floor slabs, galleries, deck slabs, beams, metal chairs, spacers and other metal accessories necessary to provide the required clear distances and proper alignment and spacing between bars shall be galvanized or shall have plastic protective covering over portions in contact with forms.

H. Clean reinforcement free of scale, loose or flaky rust or other foreign material, including oil, mud or coating that will reduce bond to concrete.

I. Accommodate placement of formed openings.

J. Maintain concrete cover around reinforcing as follows:
   1. Slabs:
      1½ inches in general, top and bottom.
      1⅜ inches at surfaces troweled as floor finish, walkway, or driveway.
      2 inches on bottom for slabs over water
   2. Footings:
DUNDEE STATE FISH HATCHERY OZONE SYSTEM
PROJECT NUMBER 128632

2 inches at top of footings.
3 inches at bottom, sides, and end of footings.

3. Walls:
   2 inches on surfaces against earth.
   1 inch on interior surfaces.

4. Beams and Girders:
   2 inches minimum to stirrup steel.
   2½ inches minimum to longitudinal steel.

5. Columns:
   2 inches in general, to main vertical reinforcement.
   2 ½ inches to main reinforcement on surfaces in contact with water.

3.2 FIELD QUALITY CONTROL:
   A. Field inspection will be performed under provisions of UGC Article 8 – Quality Control.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES

A. Cast-in-place Concrete.

B. Control, expansion, and contraction joint devices associated with concrete work including joint sealants.

1.2 RELATED SECTIONS

A. Section 03100 – Concrete Formwork: Formwork and accessories.

B. Section 03200 – Concrete Reinforcement.

1.3 REFERENCES

A. ACI 301 – Structural Concrete for Buildings.

B. ACI 302 – Guide for Concrete Floor and Slab Construction.

C. ACI 304 – Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete.

D. ACI 305R – Hot Weather Concreting.

E. ACI 306R – Cold Weather Concreting.

F. ACI 308 – Standard Practice for Curing Concrete.

G. ACI 318 – Building Code Requirements for Reinforced Concrete.

H. ANSI/ASTM D994 – Preformed Expansion Joint Filler for Concrete (Bituminous Type).

I. ANSI/ASTM D1190 – Concrete Joint Sealer, Hot-Poured Elastic Type.


N. ASTM C94 – Ready-Mixed Concrete.
P. ASTM C260 – Air Entraining Admixtures for Concrete.
Q. ASTM C330 – Light Weight Aggregates For Structural Concrete.
R. ASTM C494 – Chemicals Admixtures for Concrete.
S. ASTM C618 – Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.

1.4 SUBMITTALS

A. Submit mix designs for all concrete mixes to be used on the project. Submit mix designs as shop drawings in accordance with UGC Article 8 – Quality; Submittals a minimum of 30 days before their use in the project.

B. Submit the following under provisions of UGC Article 8 – Quality; Submittals.

1. Product data sheets on joint devices, attachment accessories, admixtures, and bonding agents.

2. Manufacturer's installation instructions.

3. Test data on proposed design mixes for each type of concrete to be used in the project to verify that the Specification requirements are met or exceeded.

C. Project Record Documents

1. Submit under provisions of UGC Article 12 – Project Completion and Acceptance.

2. Accurately record actual locations of embedded utilities and components which are concealed from view.

1.5 QUALITY ASSURANCE

A. Perform work in accordance with ACI 301.

B. Acquire cement and aggregate from the same source for all work.

C. Conform to ACI 305R when concreting during hot weather.

D. Conform to ACI 306R when concreting during cold weather.
1.6 DELIVERY, STORAGE, AND HANDLING

A. Materials shall be delivered, stored, and handled in a manner to prevent deterioration, contamination, or any other circumstances that would be harmful to cast-in-place concrete.

B. The maximum time interval between the addition of mixing water and cement to the batch and the placing of the concrete in the forms shall not exceed the following:

<table>
<thead>
<tr>
<th>Concrete Temperature</th>
<th>Time to Placement</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 to 75 degrees F</td>
<td>90 Minutes</td>
</tr>
<tr>
<td>75 degrees to 90 degrees F</td>
<td>60 Minutes</td>
</tr>
</tbody>
</table>

1.7 PROJECT CONDITIONS:

A. Do not place concrete during rain, sleet, or snow unless protection is provided and approved by the Engineer.

B. Coordinate concrete placement schedule with other related work.

C. Notify Engineer at least 48 hours before placement.

1.8 COORDINATION

Coordinate the placement of joint devices with erection of concrete formwork and placement of form accessories.

PART 2 PRODUCTS

2.1 CONCRETE MATERIALS

A. Cement

ASTM C150, Type I - Normal Portland type. Only one brand of any one type of cement shall be used for exposed concrete surfaces of any individual structure.

B. Fine Aggregates

Aggregate meeting the requirements of ASTM C33.

C. Coarse Aggregates

Aggregate sizes No. 467 or No. 57 according to ASTM C33 or as approved by the Engineer.
D. Water

Potable water free from detrimental chemicals and solids that will decrease the strength of the concrete.

E. Curing Materials

Curing materials shall be burlap, impervious sheets, or membrane-forming compounds.

2.2 ADMIXTURES

A. Air Entrainment

ASTM C260.

B. Fly Ash

ASTM C618 Class F.

2.3 ACCESSORIES

A. Vapor Barrier

Six mil thick clear polyethylene film of the type recommended for below-grade application.

B. Non-Shrink Grout

Premixed compound consisting of non-metallic aggregate, cement, and water reducing and plasticizing agents capable of developing minimum compressive strength of 2,400 psi in 48 hours and 7,000 psi in 28 days.

C. Adhesive Anchors

Two part adhesive intended for use with concrete (Hilti Hit-Hy 150 or Engineer approved equal).

2.4 JOINT DEVICES AND FILLER MATERIALS

A. Joint Filler Type A

Asphalt impregnated fiberboard or felt, 1/2 inch thick; tongue and groove profile.

B. Joint Filler Type B

One inch redwood plank with width equal to the thickness of the concrete.
C. Construction Joint Devices

Integral galvanized steel, formed to tongue and groove profile, with removable top strip exposing sealant trough, knockout holes spaced at six inches, ribbed steel spikes with tongue to fit top screed edge.

D. Expansion Joint Devices

ASTM B221, extruded aluminum; resilient elastomeric filler strip with a Shore A hardness of 35 to permit plus or minus 25 percent joint movement with full recovery; of longest manufactured length at each location, recessed mounted.

E. Sealant

Cold applied two part liquid neoprene

2.5 CONCRETE MIX

A. Design Criteria

1. Concrete shall be proportioned to give the necessary workability and strength and shall conform to the following governing requirements:

<table>
<thead>
<tr>
<th>Concrete Placement</th>
<th>Min 28 day Compressive Strength (psi)</th>
<th>Water: Cement Ratio</th>
<th>Slump (in)</th>
<th>Air Content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ozone Contact Basin</td>
<td>4,500 psi</td>
<td>0.42</td>
<td>4” ± 1”</td>
<td>4.5% ± 1.5%</td>
</tr>
<tr>
<td>Equipment Foundations &amp; Miscellaneous Concrete (Class A)</td>
<td>3,500 psi</td>
<td>0.45</td>
<td>4” ± 1”</td>
<td>4.5% ± 1.5%</td>
</tr>
<tr>
<td>Piers</td>
<td>3,000 psi</td>
<td>0.42</td>
<td>8” ± 1”</td>
<td>Do not add air entraining agents</td>
</tr>
</tbody>
</table>

2. All concrete shall be Class A, unless otherwise specified.

3. In no case shall the amount of coarse material be such as to produce harshness in placing and honeycombing in the structure.

B. Use accelerating admixtures in cold weather only when approved by the Engineer. Use of admixtures will not relax cold weather placement requirements.

C. Use calcium chloride only when approved by the Engineer.

D. Use set retarding admixtures during hot weather only when approved by the Engineer.
PART 3 EXECUTION

3.1 EXAMINATION

A. Verify existing site conditions.
B. Verify requirements for concrete cover over reinforcement.
C. Verify that anchors, seats, plates, reinforcement, and other items to be cast into concrete are accurately placed, positioned securely, and will not cause hardship in placing concrete.

3.2 PREPARATION

A. Prepare previously placed concrete by cleaning with a steel brush and applying bonding agent in accordance with the manufacturer's instructions.
B. In locations where new concrete is dowelled to existing work, install anchors as shown on the plans and according to the manufacturer's instructions.

3.3 PLACING CONCRETE

A. Place concrete in accordance with ACI 304.
B. Do not place any concrete that has a temperature of less than 50 degrees or more than 100 degrees F.
C. If the air temperature is at or below 40 degrees F, concrete work shall be performed in accordance with ACI-306R. The Contractor shall be held responsible for any defective work, resulting from freezing or injury in any manner during placing and curing, and shall replace such work at his/her expense.
D. Notify the Engineer a minimum of 48 hours prior to the commencement of placing operations.
E. Ensure reinforcement, inserts, embedded parts, formed expansion and contraction joints are not disturbed during concrete placement.
F. Install vapor barrier under interior slabs on grade. Lap joints a minimum of six inches and seal watertight by taping edges and ends.
G. Repair vapor barrier damaged during placement of concrete reinforcing. Repair with vapor barrier material. Overlap damaged areas a minimum of six inches and seal watertight.
H. Separate slabs on grade from vertical surfaces with 1/2 inch thick Type A joint filler.
DUNDEE STATE FISH HATCHERY OZONE SYSTEM
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I. Place joint filler in pattern placement sequence. Set tops to required elevations. Secure to resist movement by wet concrete.

J. Extend joint filler from bottom of slab to within 1/8 inch of finished slab surface.

K. Install joint devices in accordance with manufacturer’s instructions.

L. Install construction joint devices in coordination with floor slab pattern placement sequence. Set top to required elevations. Secure to resist movement by wet concrete.

M. Install joint device anchors. Maintain correct position to allow joint cover to be flush with finish.

N. Install joint covers in one piece when adjacent construction activity is complete.

O. Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.

P. Place concrete continuously between predetermined expansion, control, and construction joints. Do not interrupt successive placement. Do not permit cold joints to occur.

Q. Saw cut joints within 24 hours after placing concrete. Cut 1/4 depth using a 3/16 inch thick blade. Sawing shall commence as soon as the concrete has hardened sufficiently to permit cutting without chipping, spalling, or tearing and before uncontrolled shrinkage cracking of the pavement occurs.

R. Screed floors and slabs on grade level, maintaining surface flatness of maximum 1/4 inch in 10 ft.

3.4 CONCRETE FINISHING

A. Provide concrete surfaces to be left exposed with sack rubbed finish.

B. Finish concrete floor surfaces in accordance with ACI 301.

C. Steel trowel surfaces which are scheduled to be exposed.

D. In areas with floor drains, maintain floor elevation at walls. Pitch surfaces uniformly to drains at 1/8 inch per foot.

3.5 CURING AND PROTECTION

A. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.

B. Maintain concrete with minimal moisture loss at relatively constant temperature for the period necessary for hydration of cement and hardening of concrete.
C. Cure floor surfaces in accordance with ACI 308.

D. If curing by ponding, maintain 100 percent coverage of water over floor slab areas continuously for four days.

E. If curing by spraying, spray water over floor slab areas and maintain wet for seven days.

3.6 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed in accordance with ACI 301 and under provisions of UGC Article 8 – Quality Control.

B. Provide free access to the work and cooperate with the appointed testing firm.

C. Submit a proposed mix design for each class of concrete for review prior to commencement of the project.

D. Tests of cement and aggregates may be performed to ensure conformance with specified requirements.

E. Three concrete test cylinders will be taken for every 100 or less cubic yards of concrete placed. The test cylinders will be cured on-site under the same conditions as the concrete it represents.

F. One slump test will be taken for each set of test cylinders taken and as requested by the Engineer.

3.7 PATCHING

A. Allow the Engineer to inspect concrete surfaces immediately upon removal of forms.

B. Excessive honeycomb or embedded debris in concrete is not acceptable. Notify the Engineer upon discovery.

C. Patch imperfections as directed.

3.8 DEFECTIVE CONCRETE

A. Defective concrete is concrete not conforming to required lines, details, dimensions, tolerances, or specified requirements.

B. Repair or replacement of defective concrete will be determined by the Engineer.

C. Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of the Engineer for each individual area.
DIVISION 05000
METALS
PART 1 GENERAL

1.1 SECTION INCLUDES

A. Structural steel framing members and support members.

B. Base plates, shear stud connectors and expansion joint plates.

C. Grouting under base plates.

1.2 RELATED SECTIONS

A. Section 05500 - Metal Fabrications: Steel fabrications affecting structural steel work.

1.3 REFERENCES


B. AISC - Section 10 - Architecturally Exposed Structural Steel

C. ASTM A36/A36M - Structural Steel

D. ASTM A53 - Hot-Dipped, Zinc-coated Welded and Seamless Steel Pipe

E. ASTM A108 - Steel Bars, Carbon, Cold-Finished, Standard Quality

F. ASTM A123 - Zinc (Hot Dipped Galvanized) Coatings on Iron and Steel Products

G. ASTM A153 - Zinc Coating (Hot Dip) on Iron and Steel Hardware.

H. ASTM A242/A242M - High-Strength Low-Alloy Structural Steel.


J. ASTM A325 - High Strength Bolts for Structural Steel Joints.

K. ASTM A449 - Quenched and Tempered Steel Bolts and Studs

L. ASTM A490 - Quenched and Tempered Alloy Steel Bolts for Structural Steel Joints
M. ASTM A500 - Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Round and Shapes
N. ASTM A501 - Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
O. ASTM A502 - Steel Structural Rivets
P. ASTM A514/A514M - High-Yield Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding
Q. ASTM A529/A529M - Structural Steel With 42 KSI Minimum Yield Point ½ inch Maximum Thickness
R. ASTM A563 - Carbon and Alloy Steel Nuts
S. ASTM A568/A568M - General Requirements for Steel, Carbon and High-Strength Low-Alloy Hot-Rolled Sheet and Cold-Rolled Sheet
T. ASTM A572/A572M - High-Strength Low-Alloy Columbium-Vanadium Steels of Structural Quality
U. AWS A2.4 - Symbols for Welding, Brazing, and Nondestructive Examination
V. AWS D1.1 - Structural Welding Code
W. FM - Roof Assembly Classifications
X. SSPC (Steel Structures Painting Council) - Painting Manual
Y. UL - Fire Resistance Directory
Z. Warnock Hersey - Certification Listings

1.4 SUBMITTALS FOR REVIEW

A. UGC Article 8 – Quality Control; Submittals: Procedures for submittals.

B. Shop Drawings:
   1. Indicate profiles, sizes, spacing, locations of structural members, openings, attachments, and fasteners
   2. Connections.
   3. Cambers, loads
4. Indicate welded connections with AWS A2.0 welding symbols. Indicate net weld lengths

1.5 QUALITY ASSURANCE

A. Fabricate structural steel members in accordance with AISC Code of Standard Practice.

B. Fabricator: Company specializing in performing the work of this section with minimum five (5) years documented experience.

C. Erector: Company specializing in performing the work of this section with minimum five (5) years documented experience.

D. Design connections not detailed on the Drawings under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in the State of Texas.

PART 2 PRODUCTS

2.1 MATERIALS

A. Structural Steel Members: ASTM A36/A36M.

B. Structural Tubing: ASTM A500, Grade B.

C. Pipe: ASTM A53, Grade B.

D. Shear Stud Connectors: ASTM A108 Grade.

E. Bolts, Nuts, and Washers: ASTM A325 bolts, galvanized to ASTM A123 for galvanized structural members.

F. Anchor Bolts: ASTM A325. Furnish with nuts and washers. Bolts shall be stainless steel. All anchors in contact with water shall be stainless steel.

G. Welding Materials: AWS D1.1; type required for materials being welded.

H. Sliding Bearing Plates: Teflon coated.

I. Grout: Non-shrink type, pre-mixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing additives, capable of developing a minimum compressive strength of 7,000 psi at 28 days.

J. Shop and Touch-Up Primer: SSPC 15, Type 1, red oxide.
K. Expansion bolts shall be stainless steel wedge type similar to ITT Phillips Drill Co. McCullock Industries. All components shall be of Type 304 stainless. Spacing to be confirmed by manufacturer.

2.2 FABRICATION

A. Continuously seal joined members by continuous welds. Grind exposed welds smooth.
B. Fabricate connections for bolt, nut, and washer connectors.
C. Develop required camber for members.

2.3 FINISH

A. Prepare structural component surfaces in accordance with SSPC SP.
B. Shop prime structural steel members. Do not prime surfaces that will be fireproofed, field welded, in contact with concrete, and high strength bolted.
C. Galvanize structural steel members to ASTM A123. Provide minimum 1.25 oz/square foot galvanized coating.

PART 3 EXECUTION

3.1 EXAMINATION

A. Special Condition Paragraph 1.04 – Examination of Site: Verification of existing conditions prior to beginning work.

3.2 ERECTION

A. Allow for erection loads, and for sufficient temporary bracing to maintain structure safe, plumb, and in true alignment until completion of erection and installation of permanent bracing.
B. Field weld components and shear studs indicated on shop drawings.
C. Field connect members with threaded fasteners; torque to required resistance.
D. Do not field cut or alter structural members without approval of Engineer.
E. After erection, prime welds, abrasions, and surfaces not shop primed except surfaces to be in contact with concrete.
F. Grout under base plates. Trowel grouted surface smooth, splay neatly to 45 degrees.
3.3 ERECTION TOLERANCES

A. Maximum Variation From Plumb: ¼ inch per story, non-cumulative.

B. Maximum Offset From True Alignment: ¼ inch.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES

A. Shop fabricated ferrous metal items.
B. Shop fabricated aluminum items.

1.2 RELATED SECTIONS

A. Section 09800 - Painting: Paint finish.
B. Section 03305 - Cast-In-Place Concrete: Placement of metal fabrications in concrete.

1.3 REFERENCES

A. AAMA 603.8 - Performance Requirements and Test Procedures for Pigmented Organic Coatings on Extruded Aluminum.
F. ANSI A14.3 - Ladders, Fixed, Safety Requirements.
G. ASTM A36 - Structural Steel.
H. ASTM A53 - Hot-Dipped, Zinc-coated Welded and Seamless Steel Pipe.
J. ASTM A153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
K. ASTM A283 - Carbon Steel Plates, Shapes, and Bars.

L. ASTM A307 - Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.

M. ASTM A500 - Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Round and Shapes.

N. ASTM A501 - Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.


Q. ASTM B177 - Chromium Electroplating on Steel for Engineering Use.

R. ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.

S. ASTM B210 - Aluminum-Alloy Drawn Seamless Tubes.

T. ASTM B211 - Aluminum-Alloy Bar, Rod, and Wire.

U. ASTM B221 - Aluminum-Alloy Extruded Bar, Rod, Wire, Shape, and Tube.

V. AWS A2.0 - Standard Welding Symbols.

W. AWS D1.1 - Structural Welding Code.

X. SSPC (Steel Structures Painting Council) - Steel Structures Painting Manual.

1.4 SUBMITTALS FOR REVIEW

A. UGC Article 8 – Quality Control; Submittals: Procedures for submittals.

B. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable.

C. Indicate welded connections using standard AWS A2.0 welding symbols. Indicate net weld lengths.

1.5 QUALIFICATIONS

A. Prepare Shop Drawings under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in the State of Texas.
B. Welders Certificates: Submit under provisions of UGC Article 8 – Quality Control; Submittals, certifying welders employed on the Work, verifying AWS qualification within the previous 12 months.

PART 2 PRODUCTS

2.1 MATERIALS - STEEL

A. Steel Sections: ASTM A36.
B. Steel Tubing: ASTM A500, Grade B.
C. Plates: ASTM A283
E. Bolts, Nuts, and Washers: Stainless Steel.
F. Welding Materials: AWS D1.1; type required for materials being welded.
G. Ladders: ANSI A14.3.
H. Shop and Touch-Up Primer: SSPC 15, Type 1, red oxide.
I. Touch-Up Primer for Galvanized Surfaces: SSPC 20 Type I Inorganic.

2.2 MATERIALS - ALUMINUM

A. Extruded Aluminum: ASTM B221, Alloy 6063, Temper T5.
B. Sheet Aluminum: ASTM B209.
G. Bolts, Nuts, and Washers: Stainless steel.
H. Welding Materials: AWS D1.1; type required for materials being welded.

2.3 FABRICATION
A. Fit and shop assemble items in largest practical sections, for delivery to site.

B. Fabricate items with joints tightly fitted and secured.

C. Continuously seal joined members by continuous welds.

D. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.

E. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.

F. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

2.4 FABRICATION TOLERANCES

A. Squareness: 1/8 inch maximum difference in diagonal measurements.

B. Maximum Offset Between Faces: 1/16 inch.

C. Maximum Misalignment of Adjacent Members: 1/16 inch.

D. Maximum Bow: 1/8 inch in 48 inches.

E. Maximum Deviation From Plane: 1/16 inch in 48 inches.

2.5 FINISHES - STEEL

A. Prepare surfaces to be primed in accordance with SSPC SP 2.

B. Structural Steel Members: Galvanize after fabrication to ASTM A123. Provide minimum 1.25 oz/square foot galvanized coating.

C. Non-structural Items: Galvanized after fabrication to ASTM A123. Provide minimum 2.0 oz/square foot galvanized coating.

2.6 FINISHES - ALUMINUM

A. Finish coatings to conform to AAMA 603.8.

B. Exterior Aluminum Surfaces: AAMA A41, anodized to clear color.
C. Interior Aluminum Surfaces: AAMA A41, anodized to clear color.

D. Apply one coat of bituminous paint to concealed aluminum surfaces in contact with cementitious or dissimilar materials.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field conditions are acceptable and are ready to receive work.

3.2 PREPARATION

A. Clean and strip primed steel items to bare metal and aluminum where site welding is required.

B. Supply steel items required to be cast into concrete or embedded in masonry with setting templates to appropriate sections.

3.3 INSTALLATION

A. Install items plumb and level, accurately fitted, free from distortion or defects.

B. Provide for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.

C. Field weld components indicated on Drawings.

D. Perform field welding in accordance with AWS D1.1.

E. Obtain approval prior to site cutting or making adjustments not scheduled.

F. After erection, prime welds, abrasions, and surfaces not shop primed or galvanized, except surfaces to be in contact with concrete.

3.4 ERECTION TOLERANCES

A. Maximum Variation From Plumb: ¼ inch per story, non-cumulative.

B. Maximum Offset From True Alignment: ¼ inch.

C. Maximum Out-of-Position: ¼ inch.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES

A. Steel stair frame of structural sections, with open risers.
B. Open grate stair treads and landings.

1.2 RELATED SECTIONS

A. Section 05500 - Metal Fabrications.
B. Section 05720 - Aluminum Handrails and Railings: Handrails and balusters other than specified in this section.
C. Section 09800 - Painting.
D. Section 03305 - Concrete: Placement of metal anchors in concrete.

1.3 REFERENCES

B. ASTM A36 - Structural Steel.
C. ASTM A53 - Hot-Dipped, Zinc-coated Welded and Seamless Steel Pipe.
D. ASTM A123 - Zinc (Hot-Galvanized) Coatings on Products Fabricated From Rolled, Pressed and Forged Steel Shapes, Plates, Bars, and Strip.
E. ASTM A283 - Low and Intermediate Strength Carbon Steel Plates.
F. ASTM A446 - Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip process, Physical (Structural) Quality.
G. ASTM A500 - Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Round and Shapes.
H. ASTM A501 - Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.

J. ASTM E985 - Permanent Metal Railing Systems and Rails for Buildings.

K. AWS A2.0 - Standard Welding Symbols.

L. AWS D1.1 - Structural Welding Code.

M. NAAMM - Metal Stairs Manual.

N. NAAMM - Metal Bar Grating Manual.

O. SSPC (Steel Structures Painting Council) - Steel Structures Painting Manual.

1.4 DESIGN REQUIREMENTS

A. Fabricate stair assembly to support a uniform live load of 100 lb/square foot and a concentrated load of 300 lb/square foot with deflection of stringer or landing framing not to exceed 1/180 of span.

B. Railing assembly, wall rails, and attachments to resist lateral force of 200 lbs. at any point without damage or permanent set.

1.5 SUBMITTALS FOR REVIEW

A. UGC Article 8 – Quality Control; Submittals: Procedures for submittals.

B. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories.

C. Indicate welded connections using standard AWS A2.0 welding symbols. Indicate net weld lengths.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with ASTM E985 - Permanent Metal Railing Systems and Rails for Buildings.

B. Prepare Shop Drawings under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in the State of Texas. The shop drawings and calculations shall be signed and sealed by a qualified professional engineer.

C. Welders' Certificates: Submit certifying welders employed on the Work, verifying AWS qualification within the previous 12 months.
PART 2 PRODUCTS

2.1 MATERIALS

A. Steel Sections: ASTM A36.
B. Steel Tubing: ASTM A500, Grade B.
C. Plates: ASTM A283.
E. Sheet Steel: ASTM A446, Grade B Structural Quality with 1.25 oz/square foot galvanized coating.
F. Bolts, Nuts, and Washers: Stainless Steel
G. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; consistent with design of stair structure.
H. Welding Materials: AWS D1.1; type required for materials being welded.

2.2 COMPONENTS

A. Gratings: Shall be aluminum I-bar 1¾” similar to McNichols Company GIA Series with Type C abrasive nosing edge bands. Deflection under 100 lb. per 50 feet load shall be less than ¼”.

2.3 FABRICATION - GENERAL

A. Fit and shop assemble components in largest practical sections, for delivery to site.
B. Fabricate components with joints tightly fitted and secured.
C. Continuously seal joined pieces by continuous welds.
D. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.
E. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.
F. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.
G. Accurately form components required for anchorage of stairs, landings and railings to each other and to building structure.

2.4 FABRICATION - OPEN GRATING STAIRS AND LANDINGS

A. Pre-fabricate treads 1¾” inch thick in accordance with ANSI A202.1. Treads to consist of welded steel bars, bolted to supports; with abrasive nosing.

B. Standard steel channels shall be used for stringers. Minimum 10” width. Hot dip galvanize after fabrication in accordance with plans. All items to be galvanized.

C. Grating used to form landing shall be edge banded with deflections under load less than ¼ inch.

2.5 FINISHES

A. Prepare surfaces to be primed in accordance with SSPC SP 2.

B. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.

C. Do not prime surfaces in direct contact with concrete or where field welding is required.

D. Prime paint items with one coat.

E. Galvanize items to minimum 1.25 oz/square foot zinc coating in accordance with ASTM A123.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field conditions are acceptable and are ready to receive work.

3.2 PREPARATION

A. Clean and strip primed steel items to bare metal where site welding is required.

B. Supply items required to be cast into concrete and/or embedded in masonry with setting templates.

3.3 INSTALLATION

A. Install components plumb and level, accurately fitted, free from distortion or defects.
B. Provide anchors, plates, angles, hangers and struts required for connecting stairs to structure.

C. Allow for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.

D. Field weld components indicated on Drawings. Perform field welding in accordance with AWS D1.1.

E. Field bolt and weld to match shop bolting and welding. Conceal bolts and screws whenever possible.

F. Mechanically fasten joints butted tight, flush, and hairline. Grind welds smooth and flush.

G. Obtain approval prior to site cutting or creating adjustments not scheduled.

H. After erection, prime welds, abrasions, and surfaces not shop primed or galvanized, except surfaces to be in contact with concrete.

3.4 ERECTION TOLERANCES

A. Maximum Variation From Plumb: ¼ inch per story, non-cumulative.

B. Maximum Offset From True Alignment: ¼ inch.
PART 1 GENERAL

1.1 SECTION INCLUDES

A. Aluminum tube handrails, guardrails, and railing systems, including connectors, fasteners, and system required accessories.

1.2 RELATED SECTIONS

A. Section 05510 - Metal Stairs

B. Section 03305 - Concrete: Placement of anchors in concrete.

1.3 REFERENCES

A. ASTM B221 - Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes.


C. ASTM B483 - Aluminum and Aluminum-Alloy Drawn Tubes For General Purpose Applications.


E. ASTM E985 - Permanent Metal Railing Systems and Rails for Buildings.


G. ANSI A21.1 - Safety Requirements for Floor and Wall Openings, Railing, and Toe Boards.

1.4 DESIGN REQUIREMENTS

A. Railing assembly, wall rails, and attachments to resist lateral force of 200 lbs. at any point without damage or permanent set.

B. Fabricate railing assembly, wall rails, and attachments to ASTM E985.

1.5 SUBMITTALS FOR REVIEW

A. UGC Article 8 – Quality Control; Submittals: Procedures for submittals.
B. Shop Drawings: Indicate profiles, sizes, connection attachments, anchorage, size and type of fasteners, and accessories.

C. Product Data: Submit manufacturer’s specifications and installation instructions for all components

1.6 PERFORMANCE REQUIREMENTS

A. Structural Performance: Engineer, fabricate and install railing system to withstand the structural loading required by applicable codes.

B. Thermal Performance: Allow for thermal action resulting from the maximum range in ambient temperature on the design, fabrication, and installation of rail systems to prevent opening of joints, buckling, and other detrimental effects, including overstressing of connections and components.

PART 2 PRODUCTS

2.1 ALUMINUM RAILING SYSTEM

A. Rails: 1½” diameter, Schedule 40 extruded tubing conforming to ASTM B221. Maximum post spacing is 5 feet.

B. Posts: 2 x 2½ inch size, extruded tubing conforming to ASTM B221.

C. Extruded kickplate conforming to ASTM B221 and shall conform to safety requirements of ANSI A21.1

D. Fittings and Fasteners: Provide fittings and fasteners of same basic material and alloy as parts being joined, unless otherwise indicated. Provide Type 305 stainless steel blind rivets and self-tapping screws. Do not use metals that will be corrosive and incompatible with materials being fastened.

E. Mounting: Adjustable brackets and flanges, with aluminum inserts for casting in concrete and aluminum brackets for embedding into masonry.

F. Splice Connectors: Concealed spigot or collar with locking set screws; cast aluminum.

G. Exposed Fasteners: Flush countersunk screws or bolts; consistent with design of railing.

2.2 FINISHES

A. Finish coatings to conform to AAMA 603.8.
B. Exterior Aluminum Surfaces: AAM A 41 anodized, prepared with a mechanical M pre-treatment, anodized to clear color.

C. Interior Aluminum Surfaces: AAM A41 anodized, prepared with a mechanical M pre-treatment, anodized to clear color.

D. Apply one coat of bituminous paint to concealed aluminum surfaces in contact with cementitious or dissimilar materials.

2.3 FABRICATION

A. Fit and shop assemble components in largest practical sizes for delivery to site.

B. Fabricate components with joints tightly fitted and secured. Provide spigots and sleeves to accommodate site assembly and installation.

C. Provide anchors, plates and angles required for connecting railings to structure.

D. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.

E. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

F. Exterior Components: Continuously seal joined pieces by continuous welds. Drill condensate drainage holes at bottom of members at locations that will not encourage water intrusion.

G. Interior Components: Continuously seal joined pieces by continuous welds.

H. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.

I. Accurately form components to suit stairs and landings, to each other and to building structure.

J. Accommodate for expansion and contraction of members and building movement without damage to connections or members.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field conditions are acceptable and are ready to receive work.
3.2 PREPARATION

A. Clean and strip aluminum where site welding is required.

B. Supply items required to be cast into concrete and/or embedded in masonry with setting templates, to appropriate sections.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install components plumb and level, accurately fitted, free from distortion or defects.

C. Anchor railings to structure with anchors, plates or angles.

D. Conceal bolts and screws whenever possible. Where not concealed, use flush countersunk fastenings.

E. Assemble with spigots and sleeves to accommodate tight joints and secure installation.

3.4 ERECTION TOLERANCES

A. Maximum Variation From Plumb: ¼ inch per story, non-cumulative.

B. Maximum Offset From True Alignment: ¼ inch.

C. Maximum Out-of-Position: ¼ inch.

3.5 SCHEDULE

A. Install handrail where shown on plans.

B. Install handrail around any open top container or open top concrete wall that is more than 4’0” above grade.

END OF SECTION
DIVISION 09000
PAINT AND FINISHES
PART 1 GENERAL

1.1 SECTION INCLUDES:

A. The work of this section includes the coating of all interior and exterior surfaces.

1.2 REFERENCES:

A. ASTM D16--Definitions of Terms Relating to Paint, Varnish, Lacquer, and Related Products.
B. ASTM D3359--Method for Measuring Adhesion by Tape Test.
C. NACE (National Association of Corrosion Engineers)--Industrial Maintenance Painting.
E. SSPC (Steel Structures Painting Council)--Steel Structures Painting Manual.
F. TACB (Texas Air Control Board)--31 TAC Chapter 11.
G. TCEQ (Texas Commission on Environmental Quality)--30 TAC Chapter 290--Water Hygiene.
H. Paint manufacturer's printed instructions.
I. TAC--Texas Administrative Code.

1.3 DEFINITIONS:

A. dft--dry film thickness
B. mil(s)--a unit of measure equal to a thousandth of an inch (0.0254) mm.
C. VOC(s)--volatile organic compound(s)

1.4 INTERPRETATION:

A. The Engineer's decision shall be final in the interpretation and/or conflict between any of the referenced Specifications and Standards contained herein.

1.5 SUBMITTALS:
A. Information to be Provided: Provide a list of materials to be used under this Section. Submit the list before the materials are delivered to the job site. Cross reference the list to the coating systems identified. Furnish with the list, the coating manufacturer's standard product data and color chart for each material to be used.

B. Manufacturer's color charts shall be submitted to the Engineer at least 30 days or prior to paint application. Coordinate work so as to allow sufficient time for paint to be delivered to the job site.

1.6 QUALITY ASSURANCE:

A. General: Use quality assurance procedures and practices to monitor all phases of surface preparation, application and inspection throughout the duration of the project. Procedures or practices not specifically defined herein may be utilized provided they meet recognized and accepted professional standards.

B. Surface Preparation: Surface preparation will be based upon comparison with: "Pictorial Surface Preparation Standards for Painting Steel Surfaces" SSPC-VIS 1-89 and ASTM Designation D2200, "Standard Methods of Evaluating Degree of Rusting on Painted Steel Surfaces" SSPC-VIS 2 and ASTM Designation D610; "Visual Standard for Surfaces of New Steel Airblast Cleaned with Sand Abrasive".

C. Application: No coating shall be applied: When the surrounding air temperature or the temperature of the surface to be coated or painted is below the minimum surface temperature for the products specified herein; or in rain, snow, fog or mist; when the temperature is less than 5 degrees F above the dew point; when the air temperature is expected to drop below 35 degrees F within six hours after application of coating. 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. If the above conditions are forecast, coating or painting shall be completed in time to permit the film sufficient drying time prior to damage by atmospheric conditions.

D. Thickness and Holiday Checking (Steel Surfaces): Thickness of coatings shall be checked with a non-destructive, magnetic-type thickness gauge. Use as instrument such as a Tooke Gauge if a destructive tester is deemed necessary. The integrity of coated surfaces shall be checked with an approved inspection device. Non-destructive holidays shall not exceed 67½ volts nor shall destructive holiday detectors exceed the voltage recommended by the manufacturer of the coating system. For thickness between 10 and 20 mils, use a non-sudsing type wetting agent, such as Kodak Photo-Flow. Failures shall be marked, repaired in accordance with the manufacturer's printed recommendations and retested. No pinholes or other irregularities will be permitted in the final coating.

E. Inspection Devices: The contractor shall furnish, until final acceptance of coating and painting, inspection devices in good working condition for detection of holidays and
measurement of dry film thickness (dft) of coating. The Contractor shall also furnish U.S. Department of Commerce, National Bureau of Standards certified thickness calibration plates to test accuracy of dft gauges and certified instrumentation to test accuracy of holiday detector. Dry film thickness gauges and holiday detectors shall be made available for the Engineer's use at all times until final acceptance of application. Holiday detection devices shall be operated in the presence of the Engineer.

F. Warranty Inspection: Warranty inspection shall be conducted one month prior to the end of the warranty period for all coating and painting work. All defective work shall be repaired in accordance with this specification and to the satisfaction of the Engineer/Owner.

1.7 QUALIFICATIONS:

A. The Contractor shall have three years practical experience and successful history in the application of specified products to surfaces in water treatment.

1.8 SAFETY AND HEALTH REQUIREMENTS:

A. General: The Contractor shall perform all work in accordance with applicable local, state, and federal laws and regulations, and material manufacturer's instructions and recommendations pertaining to the methods, materials, or activities in the work. The Contractor shall provide and require the use of personal protective equipment for persons working on or about the project.

B. Head and Face Protection and Respiratory Devices: Equipment shall include protective helmets which shall be worn by all persons while in the vicinity of the work. In addition, workers engaged in or near the work during sandblasting shall wear appropriate eye and face protection devices and air purifying, half mask or mouthpiece respirators with appropriate filters.

C. Ventilation: Where ventilation is used to control hazardous exposure, all equipment shall be explosion-proof. Ventilation shall reduce the concentration of air contaminants to the degree a hazard does not exist. Air circulation and exhausting of solvent vapors shall be continued until coatings have fully cured.

D. Sound Levels: Whenever the occupational noise exposure exceeds maximum allowable sound levels, the Contractor shall provide and require the use of approved ear protective devices.

E. Illumination: Adequate illumination shall be provided while work is in progress, including explosion-proof lights and electrical equipment. Whenever required by the Engineer, the Contractor shall provide additional illumination and necessary supports to cover all areas to be inspected. The level of illumination for inspection purposes shall be determined by the Engineer.
F. Temporary Ladders and Scaffolding: All temporary ladders and scaffolding shall confirm to applicable safety requirements. They shall be erected where requested by the Engineer to facilitate inspection and be moved by the Contractor to locations requested by the Engineer.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Materials shall be Tnemec. Materials specified are those that have been evaluated for the specific service. Products are listed to establish a standard of quality.

Requests for substitution shall include manufacturer's literature for each product giving name, product number, generic type, descriptive information, solids by volume, recommended draft and certified laboratory test reports showing results to equal the performance criteria of the products specified herein. In addition, a list of five projects shall be submitted in which each product has been used and rendered satisfactory service. The listed projects shall be in the State of Texas.

2.2 DELIVERY AND STORAGE:

A. All materials shall be brought to jobsite in original sealed containers. They shall not be used until the Engineer has inspected contents and obtained data from information on containers or label. Materials exceeding storage life recommended by the manufacturer shall be rejected.

B. All coatings and paints shall be stored in enclosed structures to protect them from weather and excessive heat or cold. Flammable coatings or paint must be stored to conform with City, County, State and Federal safety codes for flammable coating or paint materials. At all times coatings and paints shall be protected from freezing.

2.3 MATERIALS:

The number of coats called for in this schedule shall be considered minimum. If additional coats are required for complete coverage and uniform appearance, they shall be applied. Colors will be selected by the Owner. The system numbering may not be sequential or inclusive of all numbers from the first to last system or schedule numbers.

SYSTEM NO. 1

TYPE OF SURFACE: Metal or Pre-painted Metal

TYPE OF STRUCTURE: Normal plant conditions such as: machinery, pipes, valves, equipment housing, ducts, pumps, motors, handrails, tops of digesters, covers, bridges, steel sash, doors, walkways, stairways, windows and structural steel.
EXPOSURE CONDITION: Non-Submerged; inside or outside.

SURFACE PREPARATION: All surface should be clean, dry, free of oil, rust, loose and scaling paint and foreign material.

PAINTING SYSTEM:

First Coat: Tnemec Series 27 F.C. Typoxy 2.0 to 3.0 dft mils

Second Coat: Tnemec Series 1074 Endura-Shield II (Gloss) 3.0 to 5.0 dft mils

-or-

Tnemec Series 1075 Endura-Shield II (S-G) 3.0 to 5.0 dft mils

Total Thickness Tnemec Series = 5 dft mils min.

SYSTEM NO. 2

TYPE OF SURFACE: Metal

TYPE OF STRUCTURE: Severe moisture and chemical contact and fumes such as: chemical tanks, feeders, rotary drums vacuum filters, valves, conveyors, pipes, slurry tanks, and lime and ferric sulfate or chloride tanks, interior and exterior.

EXPOSURE CONDITION: Non-Submerged; inside or outside

SURFACE PREPARATION: SSPC-SP6 Commercial Blast Cleaning. Anchor profile shall be 1.5 to 2.0 mils as per ASTM D 4417, Method C or NACE Standard RP0287.

PAINTING SYSTEM:

First Coat: Tnemec Series N69-44BR H.B. Epoxoline II Primer 2.0 to 3.0 dft mils

Second Coat: Tnemec Series N69-Color H.B. Epoxoline 4.0 to 6.0 dft mils

Third Coat (Interior): Tnemec Series N69-Color H.B. Epoxoline 4.0 to 6.0 dft mils

or

Third Coat (Exterior): Tnemec Series 1074-Color Endura-Shield II 4.0 dft mils

Total Thickness Tnemec Series = 10.0 dft mils min.
SYSTEM NO. 3

TYPE OF SURFACE: Metal

TYPE OF STRUCTURE: Piping, fittings and valves, exposed structural steel and metal trim.

EXPOSURE CONDITION: Non-Submerged

SURFACE PREPARATION: Surface must be free of moisture, oil and grease. Remove as much rust as possible by wire brushing, scraping or chipping. Color coding of piping to be as noted in Section 3.5, Paragraph B.

PAINTING SYSTEM:

First Coat: Tnemec Series 27 Chembuild 2.0-3.0 dft mils
Second Coat: Tnemec Series 1074 Endura-Shield II (Gloss) 3.0 to 5.0 dft mils
-or-
Tnemec Series 1075 Endura-Shield II (S-G) 3.0 to 5.0 dft mils
Total Thickness Tnemec = 7.0 dft mils min.

SYSTEM NO. 4

TYPE OF LIQUID HANDLED: Non-potable water

TYPE OF SURFACE: Metal

TYPE OF STRUCTURE: Trickling filter arms, gates, troughs, weirs, pipes, fittings, baffles, aerators, air diffusers, underside of digester covers, pumps, flights and skimming arms.

EXPOSURE CONDITION: Submerged or Intermittently Submerged.

SURFACE PREPARATION: SSPC-SP10 Near White Metal Blast Clean.

PAINTING SYSTEM:

First Coat: Tnemec Series 446 Perma-Shield MCU 7.0 dft mils
Second Coat: Tnemec Series 446 Perma-Shield MCU 7.0 dft mils
Total Thickness Tnemec = 14.0 dft mils min.
SYSTEM NO. 5

TYPE OF SURFACE: Concrete or Masonry

TYPE OF STRUCTURE: Interiors of building walls and ceilings, walls and ceilings in pipe galleries, pump galleries, pump and blower rooms, chlorine rooms, control chamber and cumminutor rooms.

EXPOSURE CONDITION: Non-Submerged

SURFACE PREPARATION: All surfaces must be clean and in sound condition. Painted surface should be wire brushed to remove any chalkiness and loose or peeling paint. Extremely rough concrete or masonry block should be given a cement wash before painting to provide a smooth uniform surface. No primer or surfacer is needed on smooth masonry.

PAINTING SYSTEM:

Block Filler: Tnemec Series 130-6601 65 sf/gal

First Coats: Tnemec Series N69-Color H.B. Epoxoline II 6.0-8.0 dft mils/coat

Second Coats: Tnemec Series N69-Color H.B. Epoxoline II 6.0-8.0 dft mils/coat

Total Thickness Tnemec = 12.0 dft mils min.

SYSTEM NO. 6

TYPE OF LIQUID HANDLED: Non-Potable Water

TYPE OF SURFACE: Concrete

TYPE OF STRUCTURE: Influent or effluent channels. Parshall flumes and tank structures, such as aerator, primary and secondary settling, trickling filters, clarifiers, screening, Imhoff, detritor, and digester tanks.

EXPOSURE CONDITION: Submerged

SURFACE PREPARATION: Allow new concrete to cure 28 days. Level protrusions and mortar spatter. Abrasive blast as per SSPC-SP13/NACE 6 for “Severe Service”, achieving a surface profile equal to ICRI CSP 5. Fill voids and bugholes with Tnemec Series 218 MortarClad.

PAINTING SYSTEM:

First Coat: Tnemec Series 218 MortarClad 1/32 to 1/16 of and inch
DUNDEE STATE FISH HATCHERY OZONE SYSTEM
PROJECT NUMBER 128632

Second Coat: Tnemec Series 436 Perma-Glaze FR 60.0 - 80.0 dft mils

Total Thickness Tnemec = 60.0 dft mils min.

SYSTEM NO. 7

TYPE OF LIQUID HANDLED: Potable Water

TYPE OF SURFACE: Concrete

TYPE OF STRUCTURE: Rapid mix chambers, coagulation basin, flocculation and sedimentation basins, filter beds, troughs, flumes, channels, conduits and clear wells.

EXPOSURE CONDITION: Submerged

SURFACE PREPARATION: SSPC-SP7 Brush-off blast. Masonry should be completely cured and brushed free of all form release compounds, laitance, loose particles and be completely dry. Previously coated surfaces must be cleaned of all paint, rust, grease and dirt.

Or

All surfaces shall be dry, clean and free of all contaminants. Allow new masonry to cure for 28 days. Prepare as per SSPC-SP13/NACE 6 for “Severe Service”, achieving a surface profile equal to ICRI CSP 3

PAINTING SYSTEM:

First Coat: Tnemec Series N140-44BR Beige 6.0 - 8.0 dft mils

Second Coat: Tnemec Series N140-15BL Tank White 6.0-8.0 dft mils

Total Thickness Tnemec = 12.0 dft mils min.

SYSTEM NO. 8

TYPE OF SURFACE: Concrete

TYPE OF STRUCTURE: Exterior walls of buildings and other concrete structures below grade

EXPOSURE CONDITION: Below grade
SURFACE PREPARATION: Concrete should be completely cured and brushed free of all form release compounds, laitance, loose particles and be completely dry. Previously coated surfaces must be cleaned of all loose paint, rust, grease and dirt.

PAINTING SYSTEM:

First Coat: Tnemec Series 46H-413 H.B. 16.0 dft
Tnemec-Tar mils

SYSTEM NO. 9

TYPE OF SURFACE: PVC Pipe

TYPE OF STRUCTURE: PVC Conduits and Pipes in Building

EXPOSURE CONDITION: Normal Atmosphere

SURFACE PREPARATION: Hand sand to roughen pipe surface. Clean as per SSPC-SP1 Solvent Clean with a suitable solvent to remove all linked numbers and provide a surface profile.

PAINTING SYSTEM:

First Coat: Tnemec Series N69 H.B. Epoxoline II 4.0 to 6.0 dft mils
Second Coat (Interior): Tnemec Series N69 H.B. Epoxoline II 4.0 to 6.0 dft mils
Total Thickness-Interior = 8.0 dft mils min.
Second Coat (Exterior): Tnemec Series 1075-Color Endura-Shield II (S-G) 3.0 dft mils
Total Thickness-Exterior = 7.0 dft mils min.

SYSTEM NO. 10

TYPE OF SURFACE: Tar Coated Pipe

TYPE OF STRUCTURE: Piping

EXPOSURE CONDITION: Buried
SURFACE PREPARATION: Clean and Dry

PAINTING SYSTEM:

First Coat: Tnemec Series N69-Color H.B. 3.0 dft mils
Epoxoline II Primer

Second Coat: Tnemec Series N69-Color H.B. 4.0 dft mils
Epoxoline II

Total Thickness = 7.0 dft mils min.*

*Or until bleed-through of tar is stopped.

SYSTEM NO. 11

TYPE OF SURFACE: Galvanized or Non-Ferrous Metal

TYPE OF STRUCTURE: Throughout plant

EXPOSURE CONDITION: Atmospheric

SURFACE PREPARATION: Solvent wipe as per SSPC-SP1 to remove all soluble contaminants.
Mechanically abrade as per ASTM D 6386 uniformly and thoroughly to provide tooth and anchor or chemically prepare using Henkel Galvaprep 5, as recommended by the manufacturer.

PAINTING SYSTEM:

First Coat: Tnemec Series N69 H.B. Epoxoline II 3.0-5.0 dft mils

Second Coat: Tnemec Series 1074 Endura-Shield II (Gloss) 3.0 to 4.0 dft mils

Total Thickness Tnemec = 6.0 dft mils min.

SYSTEM NO. 12

TYPE OF SURFACE: Galvanized or Non-Ferrous Metal

TYPE OF STRUCTURE: Throughout plant

EXPOSURE CONDITION: Submerged

SURFACE PREPARATION: Solvent wipe as per SSPC-SP1 to remove all soluble contaminants.
Brush-Off Blast all surfaces to be coated
DUNDEE STATE FISH HATCHERY OZONE SYSTEM
PROJECT NUMBER 128632

PAINTING SYSTEM:

First Coat: Tnemec Series N140 Pota-Pox Plus 2.0 to 4.0 dft mils
Second Coat: Tnemec Series N140 Pota-Pox Plus 6.0 to 8.0 dft mils
Total Thickness Tnemec = 8.0 dft mils min.

SYSTEM NO. 13

TYPE OF SURFACE: Metal
TYPE OF STRUCTURE: Buried
EXPOSURE CONDITION: Below grade
SURFACE PREPARATION: SSPC-SP10: Near White Metal Blast Clean. Surface to be clean and dry.

PAINTING SYSTEM: Coating system must be pinhole free.

First Coat: Tnemec Series 46H-413 H.B. Tnemec-Tar 16.0 dft mils min.

SYSTEM NO. 14

TYPE OF SURFACE: Galvanized Steel
TYPE OF STRUCTURE: Throughout plant, galvanized steel repair
EXPOSURE CONDITION: Atmospheric
SURFACE PREPARATION: SSPC-SP6: Commercial Blast Cleaning. Surface must be clean and dry.

PAINTING SYSTEM:

First Coat: Tnemec Series 90-97 Tnemec-Zinc 2.5 - 3.5 dft mils

PART 3 EXECUTION

3.1 GENERAL:

PAINTING 09800-11
A. All surface preparation, coating and painting shall conform to applicable standards of the Steel Structures Painting Council and the manufacturer's printed instructions. Material applied to the surface prior to the approval of the Engineer shall be removed and re-applied to the satisfaction of the Engineer at the expense of the Contractor.

B. All work shall be performed by skilled craftsmen qualified to perform the required work in a manner comparable with the best standards of practice. Continuity of personnel shall be coordinated with the Engineer.

C. The Contractor shall provide a supervisor at the work site during cleaning and application operations. The supervisor shall have the authority to sign change orders, coordinate work and make decisions pertaining to the fulfillment of the contract.

D. Dust, dirt, oil, grease or any foreign matter that will affect the adhesion or durability of the finish must be removed by washing with clean rags dipped in an approved cleaning solvent and wiped dry with clean rags.

E. Coating and painting systems include surface preparation, prime coating and finish coatings. Unless otherwise approved by the Engineer, prime coating shall be field applied. Where prime coatings are shop applied, the Contractor shall instruct suppliers to provide the prime coat compatible with the finish coat specified. Any off-site work which does not conform to this specification that is damaged during transportation, construction or installation shall be thoroughly cleaned and touched-up in the field as directed by the Engineer. The Contractor shall use repair procedures which insure the complete protection of all adjacent primer. The specified repair method and equipment may include wire brushing, hand or power tool cleaning, or dry-air blast cleaning. In order to prevent injury to surrounding painted areas, blast cleaning may require use of lower air pressure, smaller nozzle and abrasive particle sizes, or shorter blast nozzle distance from surface shielding and masking. If damage is too extensive or uneconomical to touch-up, then the item shall be re-cleaned and coated as directed by the Engineer.

F. The Contractor's coating and painting equipment shall be designed for application of materials specified and shall be maintained in first class working condition. Compressors shall have suitable traps and filters to remove water and oils from the air.

G. Application of the first coat shall follow immediately after surface preparation and cleaning and before rust bloom occurs. Any cleaned areas not receiving first coat within this period shall be re-cleaned prior to application of first coat.

H. Prior to assembly, all surfaces made inaccessible after assembly shall be prepared as specified herein and shall receive the coating or paint system specified.

3.2 SURFACE PREPARATION:

A. The latest revision of the following surface preparation specifications of the Steel Structures
Painting Council shall form a part of this specification:

1. **Solvent Cleaning (SSPC-SP1):** Removal of oil, grease, soil and other contaminants by use of solvents, emulsions, cleaning compounds, steam cleaning or similar materials and methods which involve a solvent or cleaning action.

2. **Hand Tool Cleaning (SSPC-SP2):** Removal of loose rust, loose mil scale and other detrimental foreign matter to degree specified by hand chipping, scraping, sanding and wire brushing.

3. **Power Tool Cleaning (SSPC-SP3):** Removal of loose rust, loose mil scale and other detrimental foreign matter to degree specified by power wire brushing, power impact tools or power sanders.

4. **White Metal Blast Cleaning (SSPC-SP5):** Blast cleaning to a gray-white uniform metallic color until each element of surface area is free of all visible residues.

5. **Commercial Blast Cleaning (SSPC-SP6):** Blast cleaning until at least two-thirds of each element of surface area is free of all visible residues.

6. **Brush-Off Blast Cleaning (SSPC-SP7):** Blast cleaning to remove loose rust, loose mil scale and other detrimental foreign matter to degree specified.

7. **Near White Blast Cleaning (SSPC-SP10):** The removal of all visible oil, grease, dirt, dust, mil scale, rust, paint, oxides, corrosion products and other foreign matter by compressed air nozzle blasting, centrifugal wheels or other specific method. Discoloration caused by certain stains shall be limited to no more than 5% of each square inch of surface area.

8. **Power Tool Cleaning to Bare Metal (SSPC-SP11):** The removal of all visible oil, grease, dirt, mil scale, rust, paint, oxide, 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. Differs from SSPC-SP3 in that it requires more thorough cleaning and a surface profile not less than 1 mil (25 microns). For areas where abrasive blasting is prohibited or not feasible.

B. Slag and weld metal accumulation and spatters not removed by the Fabricator, Erector or Installer shall be removed by chipping and grinding. All sharp edges shall be penned, ground or otherwise blunted as required by the Engineer.

C. Field blast cleaning for all surfaces shall be by dry method unless otherwise directed.

D. Particle size of abrasive used in blast cleaning shall be that which will produce a 1.5-2.0 mils (37.5 microns-50.0 microns) surface profile or in accordance with recommendations of the manufacturer of the specified coating or paint system to be applied.
E. Abrasive used in blast cleaning operations shall be new, washed, graded and free of contaminants that would interfere with adhesion of coating or paint and shall not be reused unless specifically approved by the Engineer.

F. During blast cleaning operations, caution shall be exercised to insure that existing coatings or paint are not exposed to abrasion from blast cleaning.

G. The Contractor shall keep the area of his work and the surrounding environment in a clean condition. He shall not permit blasting materials to accumulate as to constitute a nuisance or hazard to the accomplishment of the work, the operation of the existing facilities, or nuisance to the surrounding environment.

H. Blast cleaned surfaces shall be cleaned prior to application of specified coatings or paint. No coatings or paint shall be applied over damp or moist surfaces.

I. All welds shall be neutralized with a suitable chemical compatible with the specified coating materials.

J. **Specific Surface Preparation:** Surface preparation for the specific system shall be as noted in Section 2.1.

3.3 **APPLICATION:**

A. Coating and paint application shall conform to the requirements of the Steel Structures Painting Council Paint Application Specification SSPC-PA1, latest revision, for "Shop, Field and Maintenance Painting", the American Water Works Association and the manufacturer of the coating and paint materials.

B. Thinning shall be permitted only as recommended by the manufacturer approved by the Engineer, and utilizing the thinners stated in Section 2.2 Paragraphs D and E.

C. Each application of coating or paint shall be applied evenly, free of brush marks, sags, runs, with no evidence of poor workmanship. Care shall be exercised to avoid lapping on glass or hardware. Coatings and paints shall be sharply cut to lines. Finished surfaces shall be free from defects or blemishes.

D. Protective coverings or drop cloths shall be used to protect floors, textures, and equipment. Care shall be exercised to prevent coatings or paints from being spattered onto surfaces which are not to be coated or painted. Report surfaces from which materials cannot be satisfactorily removed to the Engineer.

E. When two coats of coating or paint are specified, where possible, the first coat shall contain sufficient approved color additive to act as an indicator of coverage or the two coats must be of contrasting color.
F. Film thicknesses per coat specified in Section 2.2 are minimum required. If roller application is deemed necessary, the Contractor shall apply additional coats to achieve the specified thickness.

G. All material shall be applied as specified.

H. All welds and irregular surfaces shall receive a brush coat of the specific product prior to application of the first complete coat.

3.4 COATING SYSTEM APPLICATION:

A. After completion of surface preparation as specified for the specific system, materials shall be applied at noted in Section 2.2.

3.5 COLOR SCHEME:

A. The Engineer shall select colors for the project. The Contractor shall submit a current chart of the manufacturer's available colors to the Engineer thirty days prior to the start of coating and painting.

B. The identification of influent, effluent, waste backwash, and chemical feed lines shall be accomplished by use of labels or various colors of paint. Where labels are used, they shall be placed along the pipe at no greater than five foot intervals. Where colors are used they shall follow the color code prescribed below. Color coding must be by solid color or banding. If bands are used, they shall be placed along the pipe at no greater than five foot intervals. The color code is as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Color (Tnemec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pumps, Rotors, Blowers, Motors, Baseplates, Misc. Equipment, and Exposed Iron or Steel Piping -</td>
<td></td>
</tr>
<tr>
<td>Potable Water</td>
<td>BB42 Clear Sky</td>
</tr>
<tr>
<td>Non-Potable Water</td>
<td>BF82 Cloud</td>
</tr>
<tr>
<td>Air</td>
<td>AW42 Patina</td>
</tr>
<tr>
<td>Sewage</td>
<td>BG62 Slate Gray</td>
</tr>
<tr>
<td>Chlorine Gas</td>
<td>BW56 Bright Yellow</td>
</tr>
<tr>
<td>Chlorine Solution</td>
<td>Yellow w/ Red Bands</td>
</tr>
<tr>
<td>Gas</td>
<td>CC13 Safety Red</td>
</tr>
<tr>
<td>Caustic</td>
<td>Orange</td>
</tr>
<tr>
<td>Ferric Sulfate</td>
<td>CC13 Safety Red</td>
</tr>
<tr>
<td>Polymer</td>
<td>AC12 Banyon Bark</td>
</tr>
<tr>
<td>Polymer Aid</td>
<td>AC12 Banyon Bark</td>
</tr>
<tr>
<td>Ammonia</td>
<td>Yellow/Brown Bands</td>
</tr>
<tr>
<td>Settled Water</td>
<td>Green</td>
</tr>
</tbody>
</table>
Filter Effluent  BB42 Clear Sky  
Backwash  BB42 Clear Sky  
Drain  Dark Gray  
Raw Water  2001 Warm Beige  

Hoists, Supports, Bridge Cranes and Monorails  BV57 Safety Yellow  
Structural Steel Members, Bar Joists, Roof Decks, Support Angles, Embedded Frames  AC12 Banyon Bark  
Electrical Enclosures, Panels, and Supports  BF82 Cloud  
Hollow Metal Doors, Roll Up Doors, Metal Frames, Steel Windows, & Subframes  AD12 Terra Cotta  
Wood Doors and Frames  AD12 Terra Cotta  
Gutters and Downspouts  AD12 Terra Cotta  
Interiors All Concrete Masonry Unit Walls  AL82 Warm Sun  
Exterior Standard Concrete Masonry Unit Walls  1788 Coral Sand  
Interior Drywall  AL82 Warm Sun  
Concrete  Pearl Grey  

Irrespective of the finish coat color designations, the following shall be painted as listed:

**OSHA Orange:** Moving parts of equipment, protected by guards-shafts, couplings, pulleys, and sprockets (the guards themselves to be same color as equipment color).

**OSHA Yellow:** Caution signs and all physical hazards, outside levers, weight on check valves, lower pulley block sprockets and chains on valve operators, inside of openings adjacent to steps on ladder, platforms subject to being struck.

**Dark Green:** “Safety” and location of First-Aid equipment such as gas masks, first-aid kits, and safety deluxe showers.

**Black & White:** Areas to remain clear.

3.6 DISINFECTION:

A. Disinfection may be required for interior surfaces of tanks or systems containing potable water. Coordinate painting with disinfection requirements.
3.7 VAPOR REMOVAL:
A. All solvent vapors shall be completely removed by suction-type exhaust fans and blowers before placing tank or system in operating service.

3.8 CLEAN UP:
A. Upon completion of the work, all staging, scaffolding and containers, waste blast abrasive, or other painting debris shall be removed from the site. Coating or paint spots or oil stains upon adjacent surfaces shall be removed and the jobsite cleaned. All damage to surfaces resulting from the work of this section shall be cleaned, repaired, or refinished to the satisfaction of the Engineer at no cost to the Owner.

3.9 SCHEDULE:
A. Piping:
   1. All submerged iron or steel pipe, valves, fittings, and appurtenances: System No. 4.
   2. All indoor or outdoor exposed polyvinyl chloride pipe, valves, fittings, and appurtenances: System No. 16.

B. Miscellaneous Metals:
   1. Exterior Structural Steel Members: System No. 3.

C. Concrete:
   1. Manholes, Below Grade Wet Wells and Valve Vaults: System No. 10.

END OF SECTION
DIVISION 11000
EQUIPMENT
PART 1 GENERAL

1.1 Section Includes:

A. This section includes all material, labor and other items necessary to furnish, install, and test, all ozone equipment, air compressor, pressure swing adsorption, dryer, ozone generator, ozone control panels, biologist office HMI/workstation, Lake Diversion pump station RTU, radio telemetry, including interface to ozone contact basin (reactor) instrumentation, motor operated valves, electrical standby power generator, cooling water skid, injections skids, flash reactor, ozone destruct, ozone generator cooling system, pipe supports, anchors, fittings, valves, specials as shown and specified, and the installation of ozone equipment and appurtenances furnished by others, for process and plumbing piping systems.

1.2 RELATED SECTIONS

A. UGC Article 8 Quality Control.
B. Section 13420 Flow Meters
C. Section 16100 Basic Materials and Methods for Electrical Installations.
D. Section 16500 Instrumentation Devices.
E. Section 16600 Control Narratives.
F. Section 16700 SCADA.

1.3 SUBMITTALS

A. The ozone generator manufacturer shall provide the submittals specified in Schedule 1-2 and as listed in UGC Article 8 – Quality Control; Submittals.
B. Submit Product Data and Shop Drawings in sufficient detail to confirm compliance with requirements of this Section.
C. Submit Product Data and Shop Drawings in one complete submittal package. Partial submittals are unacceptable.

1. Design Drawings:
   Include enclosure layout. Note location and sizes of all connections to the enclosure and each piece of skid mounted equipment.

2. Shop Drawings and Product Data:
   a. Catalog cuts and product specifications for each product specified.
   b. Pump Performance Curves and Data: Show head, capacity, hp demand, and
pump efficiency curves from shut-off to maximum capacity of pump. Show head, capacity, hp demand, and pump efficiency for design points.

c. Proposed coating system. Submit in accordance with Section 09800.

d. Standard wiring diagrams unless wiring diagrams are specially prepared and submitted as Shop Drawings.

3. Factory Test Data: As noted in this Specification Section

4. Performance Warranty Test Data: As noted in this Specification Section

5 O&M Manuals:
   a. Include O&M data for each piece of equipment, panel, and field device:
   b. Instruction Manual: Includes detailed operating sequence descriptions
   c. Maintenance Manual: Instructions for maintaining equipment to include calibrating, cleaning, and trouble shooting.
   d. PLC ladder logic software (electronic and printed) including tags, comments, operational database values and passwords or pass codes.
   e. Configured software on electronic media to install program on spare PLC processors and programmable controller.
   f. Bill of materials.
   e. Front and rear panel layout drawings.
   g. Name plate data.

6. As-built Drawings: UGC Article 12 – Project Completion and Acceptance

PART 2 PRODUCTS

2.1 DESIGN REQUIREMENTS

A. The ozone generator manufacturer shall furnish a complete ozone system, of the manufacturer’s standard design for water treatment facilities, capable of meeting the full range of ozone dosage requirements under the conditions specified:

   Hydraulic Capacity  729-2,000 gallons per minute (gpm)
   Dissolved Ozone Dosage  Average: 6.5 mg/L
   Ozone Dosage  156 pounds per day (lb./day)
DUNDEE STATE FISH HATCHERY OZONE SYSTEM
PROJECT NUMBER 128632

Ozone Gas Concentration  PSA Systems: Rated: 11% Range: 10 - 12%

Feed Water Pressure  3.0 pounds per square inch (psi) – 6.9 psi

Feed Water Bromide: 0.2 - 0.8 mg/L

Feed Water Salinity: > 3.0 parts per thousand (ppt)

Water Temperature: Between 35°F and 90°F

Feed Water Golden Alga Counts: 20,000 - 40,000 cells per milliliter

Feed Water pH: 7.7 to 8.1

B. For specific purposes of standardization and total system responsibility, equipment included in this section shall be furnished by single manufacturer.

C. Design per NFPA 53, "Recommended Practice on Materials, Equipment and Systems Used in Oxygen-Enriched Atmosphere."

1. If ambient oxygen inside enclosure goes to 21 percent oxygen, shut down the entire ozone system and alarm.

2.2 MATERIAL FOR CONSTRUCTION AND HIGH PURITY CLEANING

A. Materials for Construction:

1. All outdoor equipment shall be wash-down rated.

2. Equipment to be placed outdoors shall be acceptable for outdoor use with high UV exposure.

3. Outdoor equipment shall be protected from freezing.

4. Suitable for use with mildly corrosive water.

B. All supplied equipment, instruments, valves and other parts exposed to oxygen gas or ozone shall be cleaned for oxygen service at the factory prior to shipment based on the latest edition of the following standards:

1. CGA G-4.1

2. ASTM G 93

3. ASTM A 380

4. ASTM A 967

2.3 MAJOR COMPONENTS
The ozone generator manufacturer shall furnish the major components listed below:

A. Air compressor
B. Pressure Swing Adsorption Oxygen Generation System and/or Ambient Air System Driers
C. Ozone Generators
D. Power Supply Units
E. Ozone Cooling Water System
F. Ozone Injectors
G. Injector pumps
H. Gas separators
I. Static mixer
J. Liquid and gas ozone analyzers including AIT-906, AIT-1102, AIT-1104, AIT-1105 and related sample pumps, piping, heat tracing, insulation, valves and related appurtenances.

K. Ozone Destruct Units
L. Ozone System Control Panels
M. Enclosure
N. Field Valves and Instruments
O. Injection meters
P. Spare Parts
Q. Biologist office HMI/workstation and related radio telemetry
R. Lake Diversion pump station RTU and related radio telemetry

2.4 OZONE SYSTEM ENCLOSURE

A. Provide an enclosure to house majority of the ozone generator equipment with design requirements as listed in Table 2-2. Enclosure to be mounted centered on concrete pad indicated on drawings. Provide for loading and unloading enclosure without damage to pre-installed systems within the enclosure.

1. Housing: Ozone generator system shall be delivered in a new 14 gauge standard sized shipping container to reduce contractor installation, improve quality control of the ozone system, and provide protection to the equipment. All equipment shall be
installed, wired, and factory tested prior to shipment.

2. Maximum Housing Size: 50-0” in overall length x 10’-10” in overall width, 10’-10” in overall height

3. Design: All buildings and structures shall be designed to resist a horizontal wind pressure on all surfaces exposed to the wind, allowing for wind in any direction, of 35 lbs. per square foot for a building less than 30 feet tall. No allowance shall be made for the shielding effect of other buildings or structures. Minimum wind load shall be 90 mph.

4. Equipment in Housing:
   a. Pressure swing adsorption oxygen generation system and ambient air system driers and air compressor.
   b. Ozone generator
   c. Power supply units
   d. Ozone injection system, gas de-separator skids
   e. Ozone system control panel
   f. Other related valves and instruments

5. Materials of Construction:
   a. Exterior: 14 gauge metal exterior; Exterior and interior coated with Tnemec Series 66 or N69 Polyamide Epoxy, or equal, Surface prep: SSPC-SP6 Primer Coat: 3-5 mils MDFT; Finish Coat: 4-6 mils MDFT; Color to be selected by Owner.
   b. Interior: Insulated enclosure at minimum R13 for walls, roof, and floor.
      - Steel framing behind finished walls and ceiling
      - 3” mineral wool insulation behind finished walls and ceiling
      - 3/16” commercial grade embossed rubber tile flooring over existing sheet metal floor

6. Appurtenances
   a. ISO corner castings on top and bottom corners
   b. Double swing-out cargo doors one end
   c. An 18 gauge steel personnel door with an entry lock, door sweep, rain gutter, interior door gasket kit and threshold plate.
DUNDEE STATE FISH HATCHERY OZONE SYSTEM
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d. 3068 Tidalwave aluminum marine mandoor with Kason latch/ safety chain with viewing window

e. High efficiency fluorescent lights to provide superior illumination to work and maintain the ozone equipment inside the container without open doors.

f. Two (2) Light switches

g. One (1) 100 Amp 1 distribution panel

h. Exterior light: a Total of (4) 100W wall pack exterior light over man door, end of container by destruct, middle of the container, other end of the container Automatic on at dusk, switch override. LED lights will be acceptable

i. Courtesy electrical outlets: 3 inside the enclosure 1 outside the enclosure rated for outdoor use, gasketed cover, GFI protected.

j. Provide one (1) fire extinguisher mounted at exit.

7. Main Electrical Connection: One electrical connection of 480V 3-phase power into the enclosure at location as noted on drawings.


   a. Type: Electric (no natural gas provided)

   b. Maximum Voltage: 480 Volts (V) - 3 phase

   c. Indoor Design Temperature: 80 F summer, 40 F winter

   d. Winter Design Temperature: -10 F e. Summer Design Temperature: 115 F

9. Air Monitoring: Ambient ozone and oxygen monitors shall be provided within container. A horn and light stack shall be provided at each mandoor that indicates high ambient conditions within container. An automatic exhaust fan shall be included for emergency venting of container if ambient conditions exist.

10. Ventilating Equipment: Provided by generator manufacturer per codes.

2.5 PRESSURE SWING ADSORPTION OXYGEN GENERATION SYSTEM

A. The ozone generator manufacturer shall furnish a Pressure Swing Adsorption Oxygen Generation System (PSA) meeting the following requirements:

   1. Air Compressor:

      a. Type: High efficiency electric compressor with auto drain filters and pressure indicators.
b. Location: Inside of container

c. Local disconnect in NEMA 4x panel per current NEC

d. Equipment Pad: PSA system oxygen and air tank(s) to be installed outside shall be on a concrete equipment pad by others.

e. Skid Framework: If provided, Welded carbon steel Coated with Tnemec Series 66 or N69 Polyamide Epoxy, or equal Surface prep: SSPC-SP6 Primer Coat: 3-5 mils MDFT Finish Coat: 4-6 mils MDFT. Skid can contain ozone manufacturers supplied air dryer and receiver tank which may also be located outside.

2. Location: PSA System oxygen and air tank(s) shall be installed outside of the ozone container and rated for outdoor use. Sun shade shall be provided. All climate sensitive controls and components shall be contained within the generator enclosure and provide pipe stub outs for field connection to ozone manufacturer’s supplied air compressor installed externally to the container.

3. Air Inlet: Provide adequate air intakes for the PSA system to avoid creating a vacuum within the enclosure.

4. Oxygen Concentrator: Desiccant columns & control system Inlet filter and outlet filter.

5. Feed gas filter: Minimum retention rate 0.01 µm

6. Oxygen Production: >90 percent oxygen

7. Capacity: 1,300 to 1,600 pounds per day

8. Connections: All connections are completed by the generator manufacturer prior to shipment.

2.6 OZONE GENERATORS

A. The ozone generator manufacturer shall provide ozone generator(s) meeting the requirements listed below. The generator shall be shipped completely assembled, with all valves, controls, monitors, and other appurtenances installed, wired and tested at the factory.

1. Location: Inside generator enclosure

2. Manufacturers: Suez-Ozonia, Xylem – WEDECO

3. Number of Ozone Generators: 1

4. Capacity: 156 ppd

5. Power: 480/240V 3 phase 4-wire delta (L to G and L to N = 240v on two phases and 416V on one phase). No L-N loads allowed. 277-vac is not available.
6. Piping-Ozone Gas: Schedule 10s 316L SS

7. Local Control Panel: NEMA 12 enclosure

8. Junction Box: NEMA 12 enclosure


10. Ozone generator shall be have a vertical orientation with the potential removal of the electrodes to be done via a roof hatch in ceiling container directly above the generator.

2.7 POWER SUPPLY UNITS

A. The ozone generator manufacturer shall provide a power supply unit (PSU) meeting the requirements:

1. Location: Inside generator enclosure

2. Power: 480/240V 3 phase 4-wire delta (L to G and L to N = 240v on two phases and 416V on one phase). No L-N loads allowed. 277-vac is not available.

3. Enclosure: NEMA 12

4. The generator shall be provided with a IEEE 519 active front end filter

2.8 OZONE INJECTION SKID SYSTEMS

A. The ozone generator manufacturer shall furnish venturi injectors skids as needed to meet the requirements in this section. Two injection skids shall be designed to treat a maximum of 2,000 gpm with both skids in operation and a minimum flow of 729 gpm with one injection skid in operation. Unit shall be shipped completely assembled, with all valves, controls, monitors, and other appurtenances installed, wired and tested at the factory. The injection supply piping will be from a 6" 316L SS pipe entering the container. The ozone manufacturer shall design the piping system to receive water from this 6" pipe. The header shall be equipped with a Y STRAINER.

1. Location: Inside generator enclosure

2. Y Strainer: Type: Duplex; Opening: To be recommended by ozone manufacturer

3. Number of skids: 2

4. Power: 480/240V 3 phase 4-wire delta (L to G and L to N = 240v on two phases and 416V on one phase). No L-N loads allowed. 277-vac is not available.

5. Local control panel: NEMA 12
6. Injector: Mazzei, material 316L SS

   Inlet/Outlet connections at enclosure: 150 lb flanged B16.5. Connection pipe sized for less than 6 feet per second velocity. Pipe sizes shall be coordinated between installing contractor and ozone system supplier.

7. Piping water (both ozonated and nonozonated): Schedule 40s 316L SS DuPont Kalrez gaskets. This includes all manufacturers recommended reducers

8. Piping – Gas: Schedule 10s 316L SS DuPont Kalrez gaskets

9. Instruments – Water: Activated isolation Valve, inlet flow indicator, inlet pressure indicator, outlet pressure indicator


11. Junction Box: NEMA 12 Enclosure

12. Coating: Per manufacturer’s recommendation

13. Degas Separator:

   Number of Degas Separators 2.

   Install degas separators as manufactured by Mazzei on a skid. Material of construction to be 316 L SS with 150 lb stainless flanges to connect ozone destruct and injection piping.

14. Pipeline Flash Reactor (PFR):

   Number of Pipeline Flash Reactors 2.

   Install pipeline flash reactor as manufactured by Mazzei on above grade piping. Material of construction to be 316 L SS with 150 lb stainless flanges to connect ozone injection skid discharges pipes.

2.9 OZONE COOLING WATER SYSTEM

A. The ozone generator manufacturer shall furnish a skid-mounted cooling water system meeting the requirements listed. All components shall be skid mounted and the unit shall be shipped completely assembled, with all valves, controls, monitors, and other appurtenances installed, wired and tested at the factory.

   Air cooled chillers will be allowed for cooling water as supplied by the ozone manufacturer. Air cooled chillers and ozone system must meet or exceed the requirements of operation listed in this specification.
1. Location: Outside - 13 ton or ozone manufacturer's recommendation

2. Power: 480/240V 3 phase 4-wire delta (L to G and L to N = 240v on two phases and 416V on one phase). No L-N loads allowed. 277-vac is not available.

3. Local control panel: NEMA 4X

4. Closed Loop System:
   - Turbidity: 0.2 nephelometric turbidity units (NTU)
   - Conductivity: 20 μS/cm
   - Chlorides: 50 mg/L
   - pH: 7 – 9

5. Air separator: Material of construction: welded carbon steel coated with Tnemec series 66 or N69 polyamide epoxy, or equal; Surface prep: SSPC-SP6 primer coat: 3-5 mils MDFT; Finish coat: 4-6 mils MDFT

6. Expansion Tank: Material of construction: welded carbon steel coated with Tnemec series 66 or N69 polyamide epoxy, or equal; Surface prep: SSPC-SP6 primer coat: 3-5 mils MDFT; Finish coat: 4-6 mils MDFT

7. Cooling water pump and motor: Closed loop circulation capacity: per manufacturer (mfg)
   - Pump Type and motor type: per mfg
   - Quantity: 1 Coated with Tnemec Series 66 or N69 Polyamide Epoxy, or equal
   - Surface prep: SSPC-SP6 Primer Coat: 3-5 mils MDFT
   - Finish Coat: 4-6 mils MDFT
   - Pump Motor enclosure: TEFC; 1.15 service factor

8. Chemical pot feeder: Suitable for use with range of chemicals and feed rates that may be necessary for the cooling water system. Sized for at least 30 days operation prior to fill.

9. Strainer: Type: Duplex; Opening: 0.5 mm

10. Skid framework: Welded carbon steel; Coated with Tnemec Series 66 or N69 polyamide epoxy, or equal; Surface prep: SSPC-SP6; primer coat: 3-5 mils MDFT
    Finish coat: 4-6 mils MDFT
11. Connections: Closed loop cooling water supply, 150 lb flange; closed loop cooling water return, 150 lb flange; make-up water supply, ¾-inch hose fitting

12. Other: Sun shield by manufacturer to cover local controls

2.10 OZONE DESTRUCT UNITS

A. The ozone generator manufacturer shall furnish a two (2) skid-mounted thermal catalytic ozone destruct units meeting the requirements listed in this section. All components, except as noted, shall be skid mounted and the unit shall be shipped completely assembled, with all valves, controls, monitors, and other appurtenances installed, wired and tested at the factory.

1. Location: Outside

2. Power: 480/240V 3 phase 4-wire delta (L to G and L to N = 240v on two phases and 416V on one phase). No L-N loads allowed. 277-vac is not available.

3. Local control panel: NEMA 4X with courtesy outlet panel for outdoor use

4. Heater: Material of construction: 316LSS

5. Catalyst Chamber Material of construction: 316LSS

6. Blower: Inlet SS flexible coupling; discharge SS flexible coupling, and variable speed drive

7. Silencer: 85 dBA may be shipped loose. (Silencer not required if sound attenuation less than 85 dBA)

8. Piping: Schedule 40 316L SS for pipes 1.5” and smaller, Schedule 10 316L SS for pipes 2” and larger.

9. Instruments: Actuated flow control valve;
   Inlet gas temperature indicator;
   Pre-heated gas temperature indicating transmitter;
   Catalytic chamber pressure differential indicator;
   Blower pressure differential indicator;
   Low concentration ozone monitor

10. Skid Framework: Welded carbon steel; Coated with Tnemec Series 66 or N69 polyamide epoxy, or equal; surface prep: SSPC-SP6 primer coat: 3-5 mils MDFT’ finish coat: 4-6 mils MDFT
2.11 OZONE CONTACT TANK OFF GAS

A. The ozone generator manufacturer shall furnish a demister assembly and pressure/vacuum relief valve assembly for installation on the ozone contact tank. Off gas shall be piped back to the skid mounted ozone destruct units by the container. Piping from tank to destruct units is to be provided and installed by the contractor as shown in the Plans.

2.12 OZONE SYSTEM CONTROL

A. The ozone generator manufacturer shall furnish a local control panel, a remote biologist HMI/workstation, one remote RTU and related radio telemetry. The Ozone System Control Panel and remote laptop PC shall monitor and control all subsystems that comprise the ozone system including, but not limited to, the Pressure Swing Adsorption Oxygen Generation and/or Ambient Air System, Oxygen Regulation, Ozone Generation, Ozone Injection System, Ozone Destruct System, all monitors, flow meters, analyzers, ozone contact basin (reactor) instrumentation, motor operated valves, electrical standby generator and alarms. All components shall be mounted within the panel enclosure and within the generator enclosure. The master control panel shall be shipped completely assembled, wired and tested at the factory. The control panel shall be provided with communication ports and configured to operate with a radio telemetered SCADA system. See specifications 16500, 16600, & 16700 for descriptions of the SCADA system. Provide all necessary hardware, software and coordination to facilitate successful interface with the SCADA system.

2.13 CONTROL EQUIPMENT

A. Control Narrative

1. Auto Control: The operator may set the start/stop water flow trigger level on the ozone setup screen. The ozone generator starts and stops automatically with water flow. The start-up sequence is automatic as programmed by ozone manufacturer. When ozone production begins, the production is regulated automatically by the control system. Ozone production is calculated via multiplying the operator input dose by the actual water flow.

   If high ozone residuals are detected in the water at the exit of contactor the system will automatically reduce the dose rate, raise an alarm, and send a signal to the motor operated valve to close. The ozone plant will be shut down unless reset by the operator.

2. Manual Control: the plant starts and stops by operator push button control. When ozone production begins, the production is regulated automatically by the control system. Ozone production may be calculated via multiplying the operator input dose
by the actual water flow.

If high ozone residuals are detected in the water at the exit of contactor the system will automatically reduce the dose rate, raise an alarm, and send a signal to the motor operated valve to close. The ozone plant will be shut down unless reset by the operator.

3. A backup automatic mode of operation shall be provided which will engage when the primary dissolved ozone analyzer fails. This backup mode shall use pipeline contactor dissolved ozone analysis.

B. See related specifications 16500, 16600, & 16700

2.14 FIELD COMPONENTS AND INSTRUMENTS

A. The ozone generator manufacturer shall furnish at a minimum four (4) remote mounted liquid ozone analyzers. The liquid ozone monitors shall be enclosed in an outdoor rated NEMA 4 box and be capable of operating under the head conditions listed above. The last box shall contain two (2) liquid ozone analyzers for redundancy.

B. The ozone generator manufacturer shall furnish at a minimum the field valves listed in Schedule 1.

C. The ozone generator manufacturer shall furnish at a minimum the instruments listed in Schedule 2.

2.15 SPARE PARTS

A. The ozone generator manufacturer shall furnish the components listed in this section:

1. Dielectrics 5
2. Dielectric Fuses (if used) 50
3. Generator Vessel Head Gaskets 2
4. Generator Vessel Sight Glass 1
5. Ozone Destruct Unit Catalyst One (1) charge
6. Field Mounted Ozone Destruct Unit Catalyst One (1) charge
7. Power Supply Unit Circuit Boards One (1) set
8. Power Supply Unit Fuses One (1) set
9. Program 2 copies on DVD
10. Filters 2 of each type and size used.
11. Provide a spare dew point analyzer probe.

12. Provide critical spare parts for the closed loop chiller

13. Provide a spare thermal mass flow meter.

2.16 COATING

A. Provide per Section 09800 - Painting,

PART 3 MANUFACTURER SERVICES

3.1 FACTORY TEST

A. The ozone generator manufacturer shall conduct a full-scale factory ozone production test of the ozone generators, verifying ozone production at a minimum of the following three points:

1. Minimum capacity: 56 lb/d
2. Rated capacity: 156 lb/d
3. One intermediate production point

B. Protocol for the Factory Test shall be developed by the ozone generator manufacturer and submitted for approval prior to conducting the test. The test shall be witnessed by a representative designated by the Owner. The test data and results shall be submitted and approved prior to shipment. All faulty and defective parts shall be replaced at the factory and tested prior to shipment.

3.2 FIELD SERVICES

A. The ozone generator manufacturer shall provide qualified manufacturer representative(s) for a minimum of thirty (30) on-site working man-days to provide the services listed below. Travel, lodging and per diem expenses for the manufacturer representative(s) shall be paid by the ozone generator manufacturer.

1. Startup and Commissioning: Inspection of installation Equipment check Initial Startup Initial adjustment and system operation Performance warranty test

2. Follow-up Operator Training: 1 day minimum, on or about 3 months following substantial completion.

3. Training shall include but shall not be limited to the following:

   a. Diagnosis of the dew point analyzer and replacement of the analyzer probe.
   
   b. Closed chiller preventative maintenance
c. How recognize and diagnose instrument failures that would prevent automatic operation of the ozone system, but that would still allow manual operation of the ozone system. How to manually operate the ozone system when specified instrument failure occur.

4. Follow-up Operator 1 day minimum, on or about 12 months following substantial completion

3.3 WARRANTY

A. The ozone generator manufacturer shall warrant the furnished components, equipment, valves, controls, instruments, monitors and other appurtenances as a complete system against defect for a period of two (2) years from the date of Substantial Completion. The ozone generator manufacturer shall provide all parts, labor and expenses of qualified service personnel for any and all warranty service.

3.4 CONTRACTOR PROCESS PERFORMANCE GUARANTEE

A. Ozone Production and Yield Requirement:

1. Subject to the provisions contained herein, Contractor hereby guarantees that the Ozone Generator System will meet the design requirements in this section of the Specifications, demonstrated by providing the design dissolved ozone dosage at the design hydraulic capacity over a one month testing period.

2. Periods of down time for the ozone equipment during the testing period must be approved by the Owner. Periods of down time will not be included in the review of ozone production and yield. The testing period will not be extended due to approved periods of down time.

3. In the event that the Ozone Generator System fails to meet the requirements, Contractor will replace or modify the Ozone Generator System within 30 calendar days to meet this Guarantee. Upon completion of modifications, the contractor shall re-conduct the test at the Contractor's cost.

B. Power Usage Requirement:

1. Peak Demand and power consumption shall be no more than estimate provided in the Bid, verified, and measured over one month. Total power consumption shall be based on monthly operation and normalized on the basis of the volume of water treated.

2. In the event that the Ozone Generator System fails to meet the requirements, Contractor will replace or modify the Ozone Generator System or modify the operation of the Ozone Generator System within 30 calendar days to meet this Guarantee. Upon completion of modifications, the contractor shall re-conduct the test. If the Owner does not have beneficial use during a re-conducted test, all
costs of the system shall be the Contractor’s cost. In the event of a re-conducted test where the Owner receives beneficial use of the ozone generator system, power costs and regular staffing labor costs will be paid by the Owner with the Contractor responsible for remaining costs associated with the testing. At the Owner’s discretion, Owner may accept Contractor’s offer of a reduction in the Contract Price by an amount equal to the annualized value of excess operation and maintenance costs as noted in Part 3.7, Paragraph A of this Specification.

C. Feed/Influent Characteristics and Limitations:

1. Contractor Process Performance Guarantee is subject to the raw water provided to the Ozone Generator System with the characteristics provided in Part 2, Section 2.1 A of this Specification. If after two attempts to conduct Process Performance Tests, the feed water characteristics for any one parameter are out of the range specified in 11200 by more than ten percent (10%) and negatively impact the process or more than one parameter is out of the range by more than five percent (5%) of the values in Part 2, Section 2.1 A of this Specification and negatively impact the process, the Owner may either repeat the test at Owner’s expense or waive the requirement.

3.5 OZONE GENERATOR SYSTEM PROCESS PERFORMANCE TEST

A. The Process Performance Test is a demonstration of the product’s or process’s ability to meet pre-agreed standards. Immediately following commissioning of the Ozone Generator System by Contractor in accordance with the Specifications, but in no event beyond sixty (60) days after start-up, the Contractor shall conduct a process performance test meeting the requirements of Part 3, Section 3.4 Paragraph A.1. and B.1 of this Specification.

B. Protocol for the Performance Warranty Field Test shall be developed by the ozone generator manufacturer and Owner Representative. The test shall be performed jointly with the hatchery personnel to familiarize them with the full functionality of all systems and subsystems.

At a minimum the generator shall be subject to a 120 hour field test. As part of this 120 hours, 24 hours shall be at the 2,000 gpm 156 ppd flow and production rate. All faulty and defective parts shall be replaced.

C. Field Test Limitations: Water for testing at the Dundee fish hatchery will not be available during the months of APRIL, MAY, and JUNE. The contractor shall plan for this accordingly. Contractor shall coordinate with hatchery manager one (1) week in advance to determine hatchery schedule and how much water will be available. Hatchery manager needs time to make amiable ponds to store the water used for testing.

D. Contractor shall provide a minimum of a five-day written notice of intent to perform Process Performance Test and include the schedule of Performance Test and detailed protocol for meeting the requirements of this Guarantee.
E. The Owner will provide personnel to witness the conduct of the Performance Test.

F. The Owner shall provide all personnel, raw water, chemicals, and laboratory testing equipment and services and incidentals necessary to operate the Ozone Generator System to perform the Performance Test.

G. The Owner shall record raw water volume during each 24-hour period, water quality each week, and the approved periods of downtime.

H. Contractor shall monitor system performance and treated water quality.

I. For continuous reading instrumentation, calibration shall be performed by the Contractor at least once during the test. Owner will not provide manual testing in the event of a failure of instrumentation. If critical instrumentation is unavailable and requires system shut-down, it shall be considered an unapproved downtime and require retesting at the discretion of the Owner.

J. All analytical tests will be made in accordance with commonly approved field test and EPA Methods known to provide adequate limits of detection.

K. Contractor shall provide personnel to conduct the Process Performance Test. Contractor must be present a minimum of the first two days of the test and the last day of the test.

L. The raw water quality shall be determined based on the average of the samples taken during the test period. At the end of the Performance Test, the Owner shall provide Contractor with a copy of the raw water volume and raw water quality test data. Contractor shall then consolidate the test data and provide the Owner and Engineer with the results within 15 calendar days. The Engineer will verify whether requirements of the Process Performance Test have been met.

M. Upon verification by the Engineer of successful completion of the Process Performance Test, final payment may be authorized.

3.6 CONDITIONS

The Process Performance Guarantee set forth herein is subject to the following conditions:

A. During the test period, the ozone generator system will be operated in accordance with Contractor instructions.

B. Contractor reserves the right to inspect ozone generator system prior to testing to ensure that the system meets specified requirements for operation.

3.7 EXCLUSIVE REMEDY

A. In the event the Ozone Generator System fails to meet the Process Performance
Guarantee, Contractor’s sole obligation and Owner’s sole remedy hereunder shall be to replace or modify the Ozone Generator System. The Contractor shall replace or modify the Ozone Generator System as it deems appropriate to enable such plant to meet such Guarantee. At the Owner’s discretion, the Owner may accept Contractor’s offer of a reduction in the Contract Price by an amount equal to the additional construction and equipment costs to meet ozone production and yield and/or the annualized value over 20 years of excess power costs as an alternate remedy. However, the value of Contractor’s obligation hereunder in no event shall exceed the amount of the Performance Bond.

3.8 DISCLAIMER

A. There are no guarantees established, express, implied, or statutory except those set forth herein.

B. In no event, be it due to a breach of any guarantee hereunder or any other cause, shall contractor be liable for or obligated in any manner to pay consequential, special, or direct damages, including but not limited to, loss of profits, hatchery downtime, fines, or penalties, or suits by third parties against Owner.
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<td>12</td>
<td>Heat exchanger manual isolation butterfly valve</td>
<td>Closed Loop CW Supply</td>
<td>Cooling Water Skid</td>
<td>2</td>
</tr>
<tr>
<td>13</td>
<td>Manual isolation butterfly valve</td>
<td>Closed Loop CW Supply</td>
<td>Cooling Water Skid</td>
<td>1</td>
</tr>
<tr>
<td>14</td>
<td>Manual isolation ball valve</td>
<td>Make-Up Water</td>
<td>Cooling Water Skid</td>
<td>1</td>
</tr>
<tr>
<td>15</td>
<td>Activated isolation ball valve</td>
<td>Sidestream</td>
<td>Ozone Generator Container</td>
<td>4</td>
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<tr>
<td>16</td>
<td>Manual ball isolation valve</td>
<td>Ozone Gas</td>
<td>Ozone Generator Container</td>
<td>2</td>
</tr>
<tr>
<td>17</td>
<td>Check valve</td>
<td>Ozone Gas</td>
<td>Ozone Generator Container</td>
<td>2</td>
</tr>
<tr>
<td>18</td>
<td>Pressure regulator</td>
<td>PSA</td>
<td>Ozone Generator Container</td>
<td>2</td>
</tr>
<tr>
<td>19</td>
<td>Pressure relief valve</td>
<td>PSA</td>
<td>Ozone Generator Container</td>
<td>1</td>
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<tr>
<td>20</td>
<td>Air release valve – 10 cfm capacity, suitable for ozone gas contact</td>
<td>Ozone Off Gas to Destruct</td>
<td>Contactor/Field</td>
<td>2</td>
</tr>
</tbody>
</table>

Note: All valves shall be suitable for flowstream indicated.

All butterfly valves shall conform to AWWA C504, flanged short body pattern, AWWA Class 150B, rated for 150 psi differential pressure.
### Schedule 2
#### List of Minimum Instruments and Monitors

<table>
<thead>
<tr>
<th>Row No.</th>
<th>Instrument Type</th>
<th>Description</th>
<th>Flowstream</th>
<th>Location</th>
<th>Qty</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>AE/AIT</td>
<td>High concentration ozone monitor</td>
<td>Ozone Gas Outlet</td>
<td>Ozone Generator Container</td>
<td>1</td>
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<tr>
<td>2</td>
<td>TIT</td>
<td>Temperature indicating transmitter</td>
<td>Ozone Gas Outlet</td>
<td>Ozone Generator Container</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>FCV</td>
<td>Flow control valve</td>
<td>Cooling Water Supply</td>
<td>Ozone Generator Container</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>TI</td>
<td>Temperature indicator</td>
<td>Cooling Water Supply</td>
<td>Ozone Generator Container</td>
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</tr>
<tr>
<td>5</td>
<td>PRV</td>
<td>Pressure safety valve</td>
<td>Cooling Water Supply</td>
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<td>1</td>
</tr>
<tr>
<td>6</td>
<td>FE/FIT</td>
<td>Flow indicating transmitter</td>
<td>Cooling Water Return</td>
<td>Ozone Generator Container</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>TIT</td>
<td>Temperature indicating transmitter</td>
<td>Cooling Water Return</td>
<td>Ozone Generator Container</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>PI</td>
<td>Pump suction pressure indicator</td>
<td>Closed Loop CW Return</td>
<td>Cooling Water Skid</td>
<td>1</td>
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<tr>
<td>9</td>
<td>PI</td>
<td>Pump discharge pressure indicator</td>
<td>Closed Loop CW Return</td>
<td>Cooling Water Skid</td>
<td>1</td>
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<tr>
<td>10</td>
<td>TIT</td>
<td>Temperature indicating transmitter</td>
<td>Closed Loop CW Supply</td>
<td>Cooling Water Skid</td>
<td>1</td>
</tr>
<tr>
<td>14</td>
<td>FE/FIT</td>
<td>Flow indicating transmitter</td>
<td>Sidestream</td>
<td>Ozone Generator Container</td>
<td>2</td>
</tr>
<tr>
<td>15</td>
<td>PI</td>
<td>Injector inlet pressure indicator</td>
<td>Sidestream</td>
<td>Ozone Generator Container</td>
<td>2</td>
</tr>
<tr>
<td>16</td>
<td>PI</td>
<td>Injector outlet pressure indicator</td>
<td>Sidestream</td>
<td>Ozone Generator Container</td>
<td>2</td>
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<tr>
<td>17</td>
<td>FE/FIT</td>
<td>Flow indicating transmitter</td>
<td>Ozone Gas</td>
<td>Ozone Generator Container</td>
<td>2</td>
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<tr>
<td>18</td>
<td>FCV</td>
<td>Actuated flow control valve</td>
<td>Ozone Gas</td>
<td>Ozone Generator Container</td>
<td>2</td>
</tr>
<tr>
<td>19</td>
<td>PIT</td>
<td>Pressure indicating transmitter</td>
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<tr>
<td>20</td>
<td>AE/AIT</td>
<td>Medium concentration ozone monitor</td>
<td>Off-Gas</td>
<td>Ozone Destruct Skid</td>
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<tr>
<td>21</td>
<td>FCV</td>
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<tr>
<td>22</td>
<td>TI</td>
<td>Inlet gas temperature indicator</td>
<td>Off-Gas</td>
<td>Ozone Destruct Skid</td>
<td>1</td>
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<td>23</td>
<td>TIT</td>
<td>Pre-heated gas temperature indicating transmitter</td>
<td>Off-Gas</td>
<td>Ozone Destruct Skid</td>
<td>1</td>
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<tr>
<td>24</td>
<td>PDI</td>
<td>Catalytic chamber pressure differential indicator</td>
<td>Off-Gas</td>
<td>Ozone Destruct Skid</td>
<td>1</td>
</tr>
<tr>
<td>25</td>
<td>PDI</td>
<td>Blower pressure differential indicator</td>
<td>Off-Gas</td>
<td>Ozone Destruct Skid</td>
<td>1</td>
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<tr>
<td>26</td>
<td>AE/AIT/ASH</td>
<td>Low concentration ozone monitor</td>
<td>Vent</td>
<td>Ozone Destruct Skid</td>
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<tr>
<td>27</td>
<td>AE/AIT</td>
<td>Ambient ozone monitor</td>
<td>N/A</td>
<td>Ozone Generator Container</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>28</td>
<td>AE/AIT</td>
<td>Ambient oxygen monitor</td>
<td>N/A</td>
<td>Ozone Generator Container 1</td>
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</tr>
<tr>
<td>29</td>
<td>FE/FIT</td>
<td>Flow indicating transmitter</td>
<td>Raw Water</td>
<td>Field 1</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>PDI</td>
<td>Particulate filter pressure differential indicator</td>
<td>PSA System</td>
<td>Ozone Generator Container 1</td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>AE/AIT</td>
<td>Oxygen purity analyzer</td>
<td>PSA System</td>
<td>Ozone Generator Container 1</td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>AE/AIT</td>
<td>Oxygen dewpoint analyzer</td>
<td>PSA System</td>
<td>Ozone Generator Container 1</td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>AE/AIT</td>
<td>Residual Ozone Analyzer (three required)</td>
<td>Water Sample</td>
<td>Ozone Generator Container-Field 3</td>
<td></td>
</tr>
</tbody>
</table>
DIVISION 13000
SPECIAL CONSTRUCTION
PART 1 GENERAL

1.1 DESCRIPTION

A. Work included: Installation of new flow meters to measure the flow in various water lines and force mains as detailed in the Plans, and as specified herein, for a complete, proper, and operable installation.

B. Flow meters shall include but not be limited to the following:
   1. Primary head
   2. Remote mounted signal converter including indicator and totalizer
   3. Steel flow tube with grounding rings

1.2 RELATED SECTIONS

A. UGC Article 8 – Quality Control; Submittals

B. Section 02669 – Valves and Couplings.

1.3 QUALITY ASSURANCE

A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper installation of the work of this Section.

B. Flow Meters meeting shall be SITRANS FM MAG 5100W Electromagnetic Flow meters as manufactured by Siemens Industry Inc.

1.3 SUBMITTALS

A. Submittal data for each flow meter shall be provided to the Engineer for approval prior to delivery and shall include the following:
   1. Functional schematic showing control process.
   2. Specification data for each unit.
   3. Wiring diagrams.
4. Panel layouts with panel wiring and/or piping diagrams.

1.4 ACCEPTABLE MANUFACTURERS

A. Flow meters, signal converters, and appurtenances shall be manufactured by Siemens Industries Inc.

B. No other manufacturers shall be accepted unless approved by written addendum prior to bid opening. All flow meters shall be new and by the same manufacturer.

PART 2 PRODUCTS

2.1 GENERAL

A. Electromagnetic flow meters shall be installed in piping systems as shown in the plans and in accordance with the manufacturer’s recommendations. The meter shall consist of a flow tube, interconnecting cable, integral microprocessor-based signal converter, and accessories as required for the installation.

B. The flow meter shall be sized according to the spool size as indicated on the plans.

C. The flow meter shall measure, indicate and totalize the flow to within an accuracy of ± 0.2% of the actual flow with a sensitivity of ± 0.005 ft./sec.

2.2 FLOW TUBE

A. Each flow meter shall include a steel flow tube with ANSI B16.5 Class 150 lb flanges. The flow tube shall be EPDM lined. The measuring tube shall be stainless steel. The electrodes shall be Hastelloy, housing shall be SAE 1008 painted steel, grounding rings shall be AISI 316 stainless steel, and the terminal box shall be die-cast aluminum. The field coils shall have Class E insulation.

2.3 SIGNAL CONVERTER

A. The signal converter shall produce a 4-20 mA DC signal linear with the flow rate and shall be capable of measuring and totalizing forward and reverse flow.

B. The signal converter shall be remote mounted in a NEMA 4X stainless steel enclosure unless shown or specified otherwise. Operator interface shall be via six-key keypad and LC display and HART as standard.

C. The signal converter shall be a SITRANS FM MAG 6000 Article Number 7ME6920-1QA10-1AA0.
2.4 VERIFICATION INSTRUMENT

A. Contractor shall supply the Owner with a verification instrument. The flow meter verification instrument shall be a stand alone, portable device capable of measuring a number of selected parameters in the flow sensor and transmitter that affect the accuracy of the flow measurement.

B. Verification instrument shall be capable of storing up to 20 measurements.

C. Verification instrument shall be capable of connecting via a serial cable to a PC enabling download of data. Instrument shall include a windows program which allows printing and management of verification reports.

D. Verification of the flow meter shall consist of the following test routines:
   1. Insulation test of the entire flow meter system and cables.
   2. Test of sensor magnetic properties.
   3. Signal convertor gain, linearity, and zero points tests.
   4. Digital output test.
   5. Analog output test.

E. Verification instrument shall be SITRANS FM MAGFLO Article Number FDK-083F5061.

2.5 ELECTRICAL CHARACTERISTICS

A. Meter output shall be an isolated 4-20 mA DC signal linearly proportioned to flow rate operating into a maximum of 1,000 ohms.

B. Power requirements shall not exceed 5 watts operating on 117 VAC 60 Hz.

C. Contractor shall provide and install necessary relays, wiring, conduit, etc., to route flow meter signal to local control panels. Refer to Electrical Plans for proposed conduit.

PART 3 EXECUTION

3.1 SCOPE OF SUPPLY

A. The manufacturer's scope of supply shall include the following items:
   1. SITRANS FM MAG 5100W flow meters with grounding rings.
2. 7ME6920-1QA10-1AA0 SITRANS FM MAG 6000 signal converters.

3. FDK-085U1053 Wall Mounting Unit for signal converters.

4. FDK-085U0220 Potting Kits.

5. FDK-001STCAB Standard coil and electrode cables.

6. FDK-083F5061 SITRANS FM MAGFLO Verificator.

B. Services provided by the manufacturer shall include the following:

1. Manufacturer shall provide an inspection of each completed installation prior to start up. Inspection shall include but is not limited to the following:
   a. Check of all wiring, connections, and programming.
   b. Initial calibration and testing of each flow installation with SITRANS FM Verificator.
   c. Potting of each terminal box with FDK-085U0220 potting kit.

2. Manufacturer shall provide training for the Owner. Training shall include the following items.
   a. SITRANS FM MAG 5100W operation, wiring, and programming.
   b. SITRANS FM MAGFLO Verificator operation, testing, and calibration.

C. The Contractor shall provide all items or appurtenances not include in the Manufacturer's scope of supply or services. Materials and services provided by the Contractor shall include but are not limited to the following:

1. Contractor shall provide and install concrete vaults including all necessary excavation, backfill, aggregate, compaction, and appurtenances.

2. Contractor shall provide and install NEMA 4X enclosures including installation of all wall mounting units for signal converters, unistrut, brackets, and appurtenances.

3. Contractor is responsible for installation of the Manufacturer supplied standard coil and electrode cable from flow meter to remote mounted signal converters including all trenching, conduit, fittings, and appurtenances.
4. Contractor shall provide and install conduit and wire from signal converters to SCADA PLC as specified in the electrical plans including all fittings, unistrut, brackets, and appurtenances.

3.2 INSTALLATION

A. Flow meters installed in vaults shall be checked for visible damage to paint finish. Any damage shall be repainted in accordance with manufacturer's recommendations.

B. Each flow meter shall be installed in accordance with the manufacturer's recommendations for the minimum upstream and downstream requirements. Flow meters shall be installed a minimum of five pipe diameters downstream and three pipe diameters downstream of any pump, valve, or fitting which could create turbulent flow conditions through the flow meter.

C. Calibrate each flow meter including simulating control signals to input terminals. Set zero (0) and span all controls to conform to simulated input signal.

D. The terminal box on each flow meter installed shall be potted by the manufacturer. All flow meter terminal boxes shall be potted using a silicon dielectric gel (non-toxic, transparent, and self-healing gel). All electrical connections shall be made and verification test performed prior to potting terminal boxes.

3.3 TEST EQUIPMENT

A. Provide SITRANS FM MAGFLO Verificator for calibration of meter. Equipment certification will be valid for one (1) year and will be provided to the Engineer.

3.4 OPERATION AND MAINTENANCE MANUALS

A. Flow meter manufacturer shall provide operation and maintenance manuals.

B. Manual shall include trouble-shooting guides.

3.5 SCHEDULE

A. Dundee State Fish Hatchery Raw Waterline

1. FE/FIQT-1102, 24-in diameter Siemens 5100W Flow Meter

END OF SECTION
DUNDEE STATE FISH HATCHERY OZONE SYSTEM
PROJECT NUMBER 128632

SECTION 13421

RADAR LEVEL TRANSITTER

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Radar level transmitter for continuous monitoring of Ozone Contact Tank water level.

1.2 REFERENCES

A. UGC Article 8 – Quality Control; Submittals

1.3 SUBMITTALS FOR REVIEW

A. Product Data: Provide manufacturers data, which indicates use, operating range, total range, accuracy, and location for manufactured components.

1.4 SUBMITTALS AT PROJECT CLOSEOUT

A. Project Record Documents: Record actual locations of components and instrumentation.

1.5 ENVIRONMENTAL REQUIREMENTS

A. Do not install instruments when areas are under construction, except for required rough-in, taps, supports and test plugs.

B. Radar level transmitter shall be suitable for continuous monitoring water level in an environment exposed to ozone gas.

PART 2 PRODUCTS

2.1 TRANSMITTER

A. Manufacturer: Vega. Other manufacturer’s only acceptable when approved by the Engineer.

B. Model: Vegapuls 64 (PS64.FEGGMJHXANAXX)

C. General: Continuous level monitoring using radar technology.

D. Materials:

1. Explosion Proof rated for use in Class 1, Division 1 environments.

2. Process fitting / Material: Flange 3” 150lb RF, ASME B16.5 / 316/316L

3. Material / Seal / Process temperature: PTFE / PTFE / -40...+200 °C
DUNDEE STATE FISH HATCHERY OZONE SYSTEM
PROJECT NUMBER 128632

4. Electronics: Two-wire 4-20 mA/HART
5. Housing / Protection: Aluminium single chamber / IP66/IP68 (0.2bar)
6. Cable entry / Connection: ½NPT / Blind plug

E. Electrical: The current output shall be 4-20mA signal. Supply voltage shall be loop powered, 12-40 VDC reverse polarity protected. The electromagnetic emissions shall be EN50081-1 and compatibility immunity shall be EN50082-2. The signal shall be tied in with the SCADA system.

PART 3 EXECUTION

3.1. INSTALLATION

A. Install radar level transmitter over water level as shown on plans and in accordance with the manufacturer’s recommendations.

3.2 SCHEDULES

A. Ozone Contact Tank

1. LIT- 1101 - Radar Level Transmitter for monitoring water level in Ozone Contact Tank

END OF SECTION
DIVISION 15000
MECHANICAL
PART 1 GENERAL

1.01 SCOPE

A. Provide all labor, materials, equipment and incidental necessary to construct and disinfect, if required, all ductile iron pipe and appurtenances and test as shown on the Drawings and as specified herein.

B. Ductile iron pipe and appurtenances covered under this Section shall include all interior pipe and accessories to the outside face of structures and buildings, except where there is no joint at the outside face. Where there is no joint at the exterior face, this Section shall include all ductile iron pipe and accessories within two feet of the exterior face of the structure or building.

C. This Section includes piping and fittings in utility vaults and manholes.

1.02 SUBMITTALS

A. Complete shop drawings and product data on all piping and fittings shall be submitted to the Engineer.

B. Shop drawings shall indicate piping layout in plan and/or elevations and shall include a complete schedule of all pipe, fittings, specials, hangers and supports. Special castings shall be detailed showing all pertinent dimensions. Special coatings shall be clearly identified.

C. The Contractor shall furnish the Inspector with lists of all pieces of pipe and fittings in each shipment received. These lists shall give the serial or mark number, weight, class, size and description of each item received.

D. The Contractor shall submit written evidence to the Engineer that the products furnished under this Section will conform to the material and mechanical requirements specified herein. Certified copies of independent laboratory test results or mill test results from the pipe supplier may be considered evidence of compliance provided such tests are performed in accordance with the appropriate testing standards by experienced, competent personnel. In case of doubt as to the accuracy or adequacy of mill tests, the Engineer may require that the Contractor furnish test reports from an independent testing laboratory on samples of pipe materials.
PART 2 PRODUCTS

2.01 DUCTILE IRON PIPE (DIP)

A. Ductile iron pipe shall be manufactured in accordance with AWWA/ANSI C111/A21.11, AWWA/ANSI C150/A21.15, and AWWA/ANSI C151/A21.

B. All pipe, except specials, shall be furnished in nominal lengths of 18 to 20 feet. Sizes will be as shown on the Drawings.

C. All pipe shall have a minimum pressure rating as indicated in the following table, and corresponding minimum wall thickness, unless otherwise specified or shown on the Drawings:

<table>
<thead>
<tr>
<th>Diameter (inches)</th>
<th>Min Pressure Class (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 through 12</td>
<td>350</td>
</tr>
<tr>
<td>14 through 64</td>
<td>150</td>
</tr>
</tbody>
</table>

D. Pre-approved Manufacturers are as follows: US Pipe and American Pipe.

2.02 FITTINGS AND ACCESSORIES

A. Fittings, 48-inches and smaller, shall be ductile iron and shall conform to AWWA C110/ANSI A21.10 with a minimum rated working pressure of 250 psi. Fittings, 54 inches and larger, shall be ductile iron and shall conform to AWWA C153/ANSI A15.30 and shall have a minimum rated working pressure of 150 psi. AWWA C153 compact ductile fittings in sizes 4' through 36" are an acceptable substitute unless otherwise specified.

B. Flanged elbow fittings shall be ANSI pattern using short radius elbows except where noted differently on the Drawings. Special fittings, ductile iron wall pipes and sleeves shall conform to the dimensions and details as shown on the Drawings.

C. Thrust Collars: Thrust collars shall be welded-on ductile iron body type capable of withstanding a thrust due to 250 psi internal pressure on a dead end from either direction on that pipe size. The welded-on collars shall be continuously welded to the pipe by the pipe manufacturer.

D. Solid sleeves shall permit the connection of plain end ductile iron pipe. Solid sleeves shall meet the requirements of ANSI/AWWA C110 for long pattern and have a minimum pressure rating of 250 psi. Solid sleeves shall have mechanical or restrained joints as specified in this Section and as shown on the Drawings. Solid sleeves shall be used in locations shown on the Drawings, for make-up spool pieces, or at the direction of the Engineer. Solid sleeves shall be manufactured by ACIPCO, U.S. Pipe or McWane (Clow).

E. Tapping Saddles: Tapping saddles shall be ductile iron body type with O-ring gasket and alloy steel straps. Connection shall be flanged or mechanical joint as detailed on the Drawings. Tapping saddles shall be equal to ACIPCO A-10920 (mechanical joint) or ACIPCO A-30920 (flange joint).

F. Flange Adapter Coupling: The flange adapter coupling shall permit the connection of unthreaded, ungrooved, open-ended ductile iron pipe to ANSI/ASME B16.1, Class 125 flanges.
The flange adapter coupling shall meet the test requirements of ANSI/ASME B16.1 for Class 125 flanges. The adapter shall be a ductile iron casting incorporating gripping wedges and gasket. The gasket shall provide a compression seal between the adapter, the pipe and the adjacent flange. Flange adapter couplings are to be used in locations specifically shown on the Drawings, for connection with equipment and valves, and as directed by the Engineer. The flange adapter coupling shall be EBAA Iron Megaflange-Flange Adapter Series 2100.

2.03 JOINTS

A. General
1. Unless shown or specified otherwise, joints for buried service shall be push-on joint type for pipe and standard mechanical joint type for fittings. Joints for exposed service shall be flanged for pipe and fittings, unless shown otherwise.
2. Provide the necessary bolts for connections. All bolts and nuts shall be threaded in accordance with ANSI B1.1, Coarse Thread Series, Class 2A external and 2B internal fit. All bolts and nuts shall be made in the U.S.A.
3. In all cases, gaskets shall be made of material that will not be damaged by the fluid being transported nor by the environment in which the pipe is installed.

B. Mechanical Joints
1. Joints shall conform to AWWA C111/ANSI A21.11.
2. Bolts and nuts shall be Tee Head bolts and nuts of high strength low-alloy steel in accordance with ASTM A 242 to the dimension shown in AWWA C111/ANSI A21.11.
3. Gaskets shall be in accordance with AWWA C111/ANSI A21.11 and shall be constructed of neoprene unless otherwise shown on the Drawings.
4. Mechanical joint glands shall be ductile iron.
5. Retainer Glands: Retainer glands shall be Megalug Series 1100, as manufactured by EBAA Iron.

C. Push-On Joints: Push-on joints and gaskets shall conform to AWWA C111/ANSI A21.11. Details of the joint design shall be in accordance with the manufacturer’s standard practice such as ACIPCO “Fastite”, McWane (Clow) “Bell-Tite”, or U.S. Pipe “Tyton” joints.

D. Flanged Joints
1. Flanged joints shall conform to AWWA C115/ANSI A21.15. Flanges shall be ductile iron and shall be furnished by the pipe manufacturer.
2. Flanged joints shall be bolted with through stud or tap bolts of required size as directed. Bolt length and diameter shall conform to ANSI/AWWA C115 for Class 125 flanges shown in ANSI/ASME B16.1.
   a. Bolts for exposed service shall be zinc plated, cold pressed, steel machine bolts conforming to ASTM A 307, Grade B. Nuts for exposed service shall be zinc plated, heavy hex conforming to ASTM A 563. Zinc plating shall conform to ASTM B 633, Type II.
   b. Bolts for submerged service shall be stainless steel machine bolts conforming to ASTM A 193, Grade B8. Nuts shall be heavy hex, stainless steel conforming to ASTM A 194, Grade 8.
3. Gaskets shall be made of 1/8-inch thick, Neoprene. Gaskets may be ring type or full face type.
4. Flanged ductile iron pipe shall have flanges cast solidly or threaded to the pipe barrel. Pipe threads shall be of such length that with flanges screwed home, the end of the
pipe shall project beyond the face line of the flange. Flange and pipe shall then be machined to give a flush finish to the pipe and the flange and surface shall be normal to the axis of the pipe. Ductile iron flanges shall be of such design that the flange neck completely covers the threaded portion of the pipe to protect same against corrosion. All pipe with threaded type flanges shall be assembled, faced, and drilled at the point of manufacture, unless otherwise approved by the Engineer.

5. Flange filler shall conform to AWWA C110/ANSI A21.10. Joint bolt length shall be increased by the thickness of the flange filler.

6. Where tap or stud bolts are required, flanges shall be drilled and tapped accordingly.

E. Restrained Joints
1. Restrained joints shall be ACIPCO “FLEX-RING” or U.S. Pipe “TR-FLEX” for piping larger than 36-inches.
2. For piping 36-inches and less, restraining gaskets shall be ACIPCO “Fast-Grip” or U.S. Pipe “Field-Lok Gasket”.
3. Bolts, nuts, and joint accessories shall be in accordance with manufacturer's recommendation.
4. Gaskets shall be in accordance with manufacturer's recommendation.

2.04 WALL SLEEVES AND WALL PIPES

A. Where piping passes through concrete structures, furnish and install wall sleeves unless wall pipes or other provisions are specifically shown on the Drawings.

B. Wall Sleeves
1. For pipe sizes smaller than 3-inches, wall sleeves shall be steel oversize sleeves furnished with a full circle, integral or continuously welded waterstop collar. The sleeve seal shall be the mechanically expanded, synthetic rubber type. Provide all associated bolts, seals and seal fittings, pressure clamps or plates necessary to achieve a watertight installation. Sleeves shall extend the full thickness of the concrete. All hardware shall be 316 stainless steel. Sleeves and seal shall be Link Seal.
2. For larger pipe sizes, wall sleeves shall be statically cast ductile iron mechanical joint wall sleeves. Unless specified or shown otherwise for a specific situation, wall sleeves shall be mechanical joint bell-plain end type with waterstop/thrust collar. Sleeves shall be constructed with studs and mechanical joint retainer gland on the air side of the concrete structure.
3. Provide retainer gland where shown on the Drawings. Where the concrete structure is exposed to dirt on one side and is wet on the other side, construct with studs and glands on the dirt side. Wall sleeves shall be equal to ACIPCO A-10771.

C. Wall Pipes
1. Wall pipes shall be either statically cast ductile iron with integral waterstop/thrust collar or centrifugally cast ductile iron with a continuously welded waterstop/thrust collar. The welded-on collar shall be attached to the pipe by the manufacturer. The collar shall be capable of withstanding a thrust force caused by a 250 psi dead end load from either direction on that size pipe. Wall pipes shall be furnished uncoated on the outside and cement lined on the inside.
2. Where shown on the Drawings, provide wall pipes (flange by restrained joint) which shall bolt to a Type C wall thimble provided by the sluice gate manufacturer. Class 125
flanges shall be provided.

3. Wall pipes shall be cast and/or fabricated and lined in one manufacturer's facility and delivered to the job site ready for use.

4. Wall pipe flanges shall be located 9-inches from wall to face of flange unless otherwise noted on the Drawings.

2.05 COATINGS

A. The exterior of pipe and fittings for buried service shall be factory coated with an asphaltic coating conforming to AWWA C151/ANSI 21.51 for ductile iron pipe, AWWA C115/ANSI 21.15 for flanged pipe and AWWA C110/ANSI 21.10 for fittings. Pipe and fittings which shall be exposed or submerged shall be factory coated with a general purpose rust inhibitive primer compatible with the type of paint which will be field applied in accordance with the requirements of Section 09800 of these Specifications.

2.06 PIPE LININGS

A. Cement Linings: Unless shown or specified otherwise, ductile iron pipe and fittings shall be cement lined in accordance with AWWA C104/ ANSI A21.4, standard thickness.

B. Interior Lining: Ductile iron piping and fittings shall be epoxy lined where shown on the drawings.

C. Epoxy Lining:

1. Linings shall cover all exposed surfaces of pipe and fittings. The lining of the pipe barrel shall extend from spigot end through the socket to the edge of the gasket sealing area or recess for pipe using push-on gaskets, and to the edge of the gasket seat for mechanical joints. The lining shall also cover the exterior of the spigot end from the end of the pipe to beyond the gasket sealing area. The lining in fittings shall cover the interior surfaces including the socket areas as defined above. All linings shall be hermetically sealed at the ends.

2. Lining Material: The lining material shall be Protecto 401 Ceramic Epoxy, a two component, modified epoxy formulated for corrosion control with the following minimum requirements:

   a. A permeability rating of 0.0 perms when measured by ASTM E 96, Procedure A. Duration of the test shall be six weeks.

   b. A direct impact resistance of 125 inch-pounds with no cracking when measured by ASTM D 2794.

   c. The ability to build at least 50 mils dry in one coat.

   d. The material shall be recoatable with itself for at least seven days with no additional surface preparation when exposed to direct summer sun and a temperature of 90 degrees F.

   e. The material shall contain at least 20 percent by volume of ceramic quartz pigment.

   f. A test and service history demonstrating the ability of the material to withstand the service expected.

   g. Possess a minimum solids volume content of 88 percent, ± one percent.

   h. Possess a maximum drying time to allow recoating as follows: 50 degrees F - 72 hours; 75 degrees F - 18 hours; 90 degrees F - 8 hours. If recoating
cannot be accomplished within seven days, a light brush blast shall be performed to improve intercoat adhesion.

3. **Surface Preparation:** The interior of the pipe exposed to liquids and gases shall be blasted and cleaned to remove all loose laitance, scale, or other loose material. No lining shall take place over grease, oil, etc., that would be detrimental to the adhesion of the compound to the substrate.

4. **Application:** The lining shall be applied using a centrifugal lance applicator by workers employed by Vulcan Painters, Inc. The workers shall be experienced and competent in the surface preparation, application and inspection of the lining to be applied. The compound shall not be applied when the substrate temperature is below 40 degrees F or in adverse atmospheric conditions which will cause detrimental blistering, pinholing or porosity of the film.

5. **Lining of pipe barrel and fittings shall be 40 mils nominal thickness; minimum lining thickness shall be 30 mils. Lining thickness for exterior of spigot and interior of socket shall be 8 to 10 mils.**

6. **All pipe and fitting linings shall be tested for pinholes in accordance with ASTM G 62, Method B and shall be holiday free.**

7. **All pipe linings shall be checked for thickness using a magnetic film thickness gauge.**

8. **Each pipe joint and fitting shall be marked with the date of application of the lining system and with the numerical sequence of application of that date.**

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**2.07 EXPANSION JOINTS**

A. **The Expansion Joint shall have a rubber inner tube, a body constructed of multiple piles of fabric impregnated with synthetic rubber, and a protective outer cover of synthetic rubber to provide resistance to deterioration from weather and ozone. Special covers shall be applied when indicated on the drawings to resist weather, ozone, and corrosive fumes. Steel wire shall be imbedded in the body for additional strength.**

B. **The elastomer and fabric materials shall be determined by the temperature and chemical compatibility requirements, as indicated on the drawings.**

1. **Class 1 - to 108°F:** PGR, Neoprene, Buna-N, or Hypalon, with Nylon or Polyester reinforcement.

2. **Class II - to 250°F:** Chlorobutyl, EPDM, or Teflon®-lined, with Polyester reinforcement.

3. **Class III - to 400°F:** Solid Viton®, with Kevlar® reinforcement.

C. **Flanges shall be constructed integrally with the body to resist stresses. Flanges shall be full-pattern so that gaskets are not necessary. Flanges shall be drilled to ANSI B16.5 Class 150#. Flanges shall be accompanied with Galvanized 3/8" split steel retaining rings and enough control rods installed to achieve a working pressure of 200 psi.**

D. **The expansion joint shall be available with a single arch or multiple arches, in open or filled arch (s) construction, and with wide arch (es) as specified on the drawings. Joint dimensions, movement, and spring rates for all variations shall follow Fluid Sealing Association guidelines.**

E. **The elastomer construction of the joint acts to absorb vibration, preventing it from being**
transmitted to the piping, as well as compensation for lateral deflection. The integral arch allows for axial compression and elongation of the joint, to compensate for expansion and contraction of the piping.

F. All expansion joints shall be Redflex™ Type J-1 as manufactured by the Red alve Company, Inc. of Carnegie, PA 15105 or approved equal.

PART 3 EXECUTION

3.01 CUTTING

A. When new or existing pipe is required to be cut, the pipe shall be cut in such a manner as to leave a smooth end normal to the axis of the pipe.

B. All cutting of ductile iron pipe shall be performed with a cutting saw. All burrs shall be removed from the inside and outside edges of all cut pipe. All damaged linings and coatings shall be repaired.

C. Lining Repair: Repair linings and recoat spigot ends of cut pipe with a product equal to Protecto 101 in accordance with the manufacturer’s recommendations and as specified below:
1. Remove all burrs and areas of loose lining materials by sanding or scraping to bare metal.
2. Remove oil and lubricants used during field cutting.
3. Lining shall be stripped back a minimum of 1-inch from the spigot end into well adhered lined areas.
4. Roughen 1 to 2-inches of good lining with a rough grade (40 grit) emery paper, rasp or small chisel, to allow an overlap between new and existing lining.
5. Apply lining repair material in the number of coats required to match the thickness requirements as specified in Part 2 of this Section and in accordance with the manufacturer's recommendations.

3.02 JOINT ASSEMBLY

A. General: Ductile iron pipe shall be assembled in accordance with ANSI/AWWA C600.

B. Push-On Joints: The inside of the bell and the outside of the pipe from the plain end to the guide stripe shall be wiped clean immediately before assembling the pipe joint. Then the rubber gasket shall be inserted into a groove or shaped recess in the bell. Both the bell and spigot ends to be joined shall be wiped again to ensure they are thoroughly clean. A liberal coating of special lubricant furnished by the pipe manufacturer shall be applied to the outside of the pipe. The plain end shall be centered in the bell and the spigot pushed home.

C. Mechanical Joints
1. The surfaces with which the rubber gasket comes in contact shall be brushed thoroughly with a wire brush just prior to assembly to remove all loose rust or foreign material which may be present and to provide clean surfaces which shall be brushed with a liberal amount of soapy water or other approved lubricant just prior to slipping
the gasket over the spigot end and into the bell. Lubricant shall be brushed over the gasket prior to installation to remove loose dirt and lubricate the gasket as it is forced into its retaining space.

2. Joint bolts shall be tightened by the use of wrenches and to a tension recommended by the pipe manufacturer. When tightening bolts, the gland shall be brought up toward the pipe bell. If effective sealing is not attained at the maximum torque indicated above, the joint shall be disassembled and reassembled after thorough cleaning. Overstressing of bolts to compensate for poor installation shall not be permitted.

3. After installation, bolts and nuts in buried piping shall be given two heavy coats of a bituminous paint. Bolts and nuts for exposed or submerged service shall be coated in accordance with the requirements of Section 09800 of these Specifications.

D. Flanged Joints

1. All flanges shall be true and perpendicular to the axis of the pipe. Flanges shall be cleaned of all burrs, deformations, or other imperfections before joining. Flanged joints shall be installed so as to ensure uniform gasket compression. All bolting shall be pulled up to the specified torque by crossover sequence. Where screwed flanges are used, the finished pipe edge shall not extend beyond the face of the flange, and the flange neck shall completely cover the threaded portion of the pipe.

2. Connections to equipment shall be made in such a way that no torque is placed on the equipment flanges. Connecting flanges must be in proper position and alignment and no external force may be used to bring them together properly.

3. After installation, bolts and nuts for exposed or submerged service shall be coated in accordance with the requirements of Section 09800 of these Specifications.

4. Flanged filler shall be used only where shown on the Drawings or approved by the Engineer to make up minor differences in pipe length, less than 3-inches. Joint bolts shall be increased in length by the thickness of the flange filler.

E. Joints of Dissimilar Metals: When a flanged joint consists of a ductile iron flange mated to a steel or alloy flange, the steel flanges shall be flat faced and furnished with full-faced gaskets, insulating bushings.

3.03 DRILLING AND TAPPING

A. Wherever required ductile iron pipe and fittings shall be drilled and tapped to receive drainage or any other piping. All holes shall be drilled accurately at right angles to the axis of any pipe or fitting. Where plugs are drilled, holes shall be at right angles to the face of the plug.

B. Unless shown otherwise, small diameter pipes, less than 2-inches, shall be connected to ductile iron pipe using one of the following methods:

1. Direct tap.
2. Direct tap with service saddle.
3. Direct tap boss.
4. Tapped plug or flange on tapping saddle.

C. In no case shall the effective number of threads be less than 4.
A. All ductile iron pipes entering buildings or basins shall be adequately supported between the structure and undisturbed earth to prevent damage resulting from settlement of backfill around the structure.

3.05 CONSTRUCTING WITHIN STRUCTURES

A. Proper and suitable tools and appliances for safe and convenient handling and laying of pipe and fittings shall be used. Care shall be taken to prevent the pipe coating from being damaged, particularly cement linings on the inside of the pipes and fittings. Any damage shall be remedied as directed by the Engineer.

B. All pipe and fittings shall be carefully examined by the Contractor for defects just before installing and no pipe or fitting shall be installed if it is defective. If any defective pipe or fitting is discovered after having been installed, it shall be removed and replaced in a satisfactory manner with a sound pipe or fitting by the Contractor at Contractor's own expense.

C. All pipes and fittings shall be thoroughly cleaned before they are installed and shall be kept clean until they are used in the completed work. Open ends of pipe shall be kept plugged with a bulkhead during construction.

D. All elbows, tees, brackets, crosses, and reducers in pressure piping systems shall be adequately restrained against thrust.

E. Wall pipe and wall sleeves shall be accurately located and securely fastened in place before concrete is poured. All wall pipe and sleeves shall have wall collars properly located to be in the center of the wall where the respective pipes are to be installed. Pipe passing through the sleeve shall extend no more than three feet beyond the structure without a piping joint.

F. Wall pipe and wall sleeves shall be constructed when the wall or slab is constructed. Blocking out or breaking of the wall for later installation shall not be permitted.

G. Cutting or weakening of structural members to facilitate pipe installation shall not be permitted. All piping shall be installed in place without springing or forcing.

H. Exposed ductile iron piping shall be supported as shown on the Drawings and specified.

I. Drilled and tapped bolt hole patterns that are encased in the concrete shall be fully sealed and protected before concrete pours to prevent fouling of the threads.

3.06 FIELD PAINTING

A. Field painting of exposed and submerged pipe shall be in accordance with the requirements of Section 09800 of these Specifications.

3.07 INSPECTION AND TESTING

A. All testing shall be in accordance with the requirements of Testing Section of these Specifications.
3.08 INSULATION AND HEAT TRACING
A. Provide insulation and heat tracing in accordance with this Section of these Specifications.

3.09 DISINFECTION
A. Following installation and testing, potable water lines shall be disinfected in accordance with the requirements of Water Pipe and Fittings Section of these Specifications.

3.10 CLEANING
A. In accordance with this Section of these Specifications.

END OF SECTION
DUNDEE STATE FISH HATCHERY OZONE SYSTEM
PROJECT NUMBER 128632

SECTION 15010

DUCTILE IRON PIPING

PART 1 GENERAL

1.01 SCOPE

A. Provide all labor, materials, equipment and incidentals necessary to construct and disinfect, if required, all ductile iron pipe and appurtenances and test as shown on the Drawings and as specified herein.

B. Ductile iron pipe and appurtenances covered under this Section shall include all interior pipe and accessories to the outside face of structures and buildings, except where there is no joint at the outside face. Where there is no joint at the exterior face, this Section shall include all ductile iron pipe and accessories within two feet of the exterior face of the structure or building.

C. This Section includes piping and fittings in utility vaults and manholes.

1.02 SUBMITTALS

A. Complete shop drawings and product data on all piping and fittings shall be submitted to the Engineer.

B. Shop drawings shall indicate piping layout in plan and/or elevations and shall include a complete schedule of all pipe, fittings, specials, hangers and supports. Special castings shall be detailed showing all pertinent dimensions. Special coatings shall be clearly identified.

C. The Contractor shall furnish the Inspector with lists of all pieces of pipe and fittings in each shipment received. These lists shall give the serial or mark number, weight, class, size and description of each item received.

D. The Contractor shall submit written evidence to the Engineer that the products furnished under this Section will conform to the material and mechanical requirements specified herein. Certified copies of independent laboratory test results or mill test results from the pipe supplier may be considered evidence of compliance provided such tests are performed in accordance with the appropriate testing standards by experienced, competent personnel. In case of doubt as to the accuracy or adequacy of mill tests, the Engineer may require that the Contractor furnish test reports from an independent testing laboratory on samples of pipe materials.
PART 2 PRODUCTS

2.01 DUCTILE IRON PIPE (DIP)

A. Ductile iron pipe shall be manufactured in accordance with AWWA/ANSI C111/A21.11, AWWA/ANSI C150/A21.15, and AWWA/ANSI C151/A21

B. All pipe, except specials, shall be furnished in nominal lengths of 18 to 20 feet. Sizes will be as shown on the Drawings.

C. All pipe shall have a minimum pressure rating as indicated in the following table, and corresponding minimum wall thickness, unless otherwise specified or shown on the Drawings:

<table>
<thead>
<tr>
<th>Diameter (inches)</th>
<th>Min Pressure Class (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 through 12</td>
<td>350</td>
</tr>
<tr>
<td>14 through 64</td>
<td>150</td>
</tr>
</tbody>
</table>

D. Pre-approved Manufacturers are as follows: US Pipe and American Pipe.

2.02 FITTINGS AND ACCESSORIES

A. Fittings, 48-inches and smaller, shall be ductile iron and shall conform to AWWA C110/ANSI A21.10 with a minimum rated working pressure of 250 psi. Fittings, 54 inches and larger, shall be ductile iron and shall conform to AWWA C153/ANSI A15.30 and shall have a minimum rated working pressure of 150 psi. AWWA C153 compact ductile fittings in sizes 4' though 36" are an acceptable substitute unless otherwise specified.

B. Flanged elbow fittings shall be ANSI pattern using short radius elbows except where noted differently on the Drawings. Special fittings, ductile iron wall pipes and sleeves shall conform to the dimensions and details as shown on the Drawings.

C. Thrust Collars: Thrust collars shall be welded-on ductile iron body type capable of withstanding a thrust due to 250 psi internal pressure on a dead end from either direction on that pipe size. The welded-on collars shall be continuously welded to the pipe by the pipe manufacturer.

D. Solid sleeves shall permit the connection of plain end ductile iron pipe. Solid sleeves shall meet the requirements of ANSI/AWWA C110 for long pattern and have a minimum pressure rating of 250 psi. Solid sleeves shall have mechanical or restrained joints as specified in this Section and as shown on the Drawings. Solid sleeves shall be used in locations shown on the Drawings, for make-up spool pieces, or at the direction of the Engineer. Solid sleeves shall be manufactured by ACIPCO, U.S. Pipe or McWane (Clow).

E. Tapping Saddles: Tapping saddles shall be ductile iron body type with O-ring gasket and alloy steel straps. Connection shall be flanged or mechanical joint as detailed on the Drawings. Tapping saddles shall be equal to ACIPCO A-10920 (mechanical joint) or ACIPCO A-30920 (flange joint).

F. Flange Adapter Coupling: The flange adapter coupling shall permit the connection of unthreaded, ungrooved, open-ended ductile iron pipe to ANSI/ASME B16.1, Class 125 flanges.
The flange adapter coupling shall meet the test requirements of ANSI/ASME B16.1 for Class 125 flanges. The adapter shall be a ductile iron casting incorporating gripping wedges and gasket. The gasket shall provide a compression seal between the adapter, the pipe and the adjacent flange. Flange adapter couplings are to be used in locations specifically shown on the Drawings, for connection with equipment and valves, and as directed by the Engineer. The flange adapter coupling shall be EBAA Iron Megaflange-Flange Adapter Series 2100.

2.03 JOINTS

A. General
1. Unless shown or specified otherwise, joints for buried service shall be push-on joint type for pipe and standard mechanical joint type for fittings. Joints for exposed service shall be flanged for pipe and fittings, unless shown otherwise.
2. Provide the necessary bolts for connections. All bolts and nuts shall be threaded in accordance with ANSI B1.1, Coarse Thread Series, Class 2A external and 2B internal fit. All bolts and nuts shall be made in the U.S.A.
3. In all cases, gaskets shall be made of material that will not be damaged by the fluid being transported nor by the environment in which the pipe is installed.

B. Mechanical Joints
1. Joints shall conform to AWWA C111/ANSI A21.11.
2. Bolts and nuts shall be Tee Head bolts and nuts of high strength low-alloy steel in accordance with ASTM A 242 to the dimension shown in AWWA C111/ANSI A21.11.
3. Gaskets shall be in accordance with AWWA C111/ANSI A21.11 and shall be constructed of neoprene unless otherwise shown on the Drawings.
4. Mechanical joint glands shall be ductile iron.
5. Retainer Glands: Retainer glands shall be Megalug Series 1100, as manufactured by EBAA Iron.

C. Push-On Joints: Push-on joints and gaskets shall conform to AWWA C111/ANSI A21.11. Details of the joint design shall be in accordance with the manufacturer's standard practice such as ACIPCO "Fastite", McWane (Clow) "Bell-Tite", or U.S. Pipe "Tyton" joints.

D. Flanged Joints
1. Flanged joints shall conform to AWWA C115/ANSI A21.15. Flanges shall be ductile iron and shall be furnished by the pipe manufacturer.
2. Flanged joints shall be bolted with through stud or tap bolts of required size as directed. Bolt length and diameter shall conform to ANSI/WWA C 115 for Class 125 flanges shown in ANSI/ASME B16.1.
   a. Bolts for exposed service shall be zinc plated, cold pressed, steel machine bolts conforming to ASTM A 307, Grade B. Nuts for exposed service shall be zinc plated, heavy hex conforming to ASTM A 563. Zinc plating shall conform to ASTM B 633, Type II.
   b. Bolts for submerged service shall be stainless steel machine bolts conforming to ASTM A 193, Grade B8. Nuts shall be heavy hex, stainless steel conforming to ASTM A 194, Grade 8.
3. Gaskets shall be made of 1/8-inch thick, Neoprene. Gaskets may be ring type or full face type.
4. Flanged ductile iron pipe shall have flanges cast solidly or threaded to the pipe barrel. Pipe threads shall be of such length that with flanges screwed home, the end of the
pipe shall project beyond the face line of the flange. Flange and pipe shall then be machined to give a flush finish to the pipe and the flange and surface shall be normal to the axis of the pipe. Ductile iron flanges shall be of such design that the flange neck completely covers the threaded portion of the pipe to protect same against corrosion. All pipe with threaded type flanges shall be assembled, faced, and drilled at the point of manufacture, unless otherwise approved by the Engineer.

5. Flange filler shall conform to AWWA C110/ANSI A21.10. Joint bolt length shall be increased by the thickness of the flange filler.

6. Where tap or stud bolts are required, flanges shall be drilled and tapped accordingly.

E. Restrained Joints
1. Restrained joints shall be ACIPCO “FLEX-RING" or U.S. Pipe “TR-FLEX" for piping larger than 36-inches.
2. For piping 36-inches and less, restraining gaskets shall be ACIPCO "Fast-Grip" or U.S. Pipe "Field-Lok Gasket".
3. Bolts, nuts, and joint accessories shall be in accordance with manufacturer's recommendation.
4. Gaskets shall be in accordance with manufacturer's recommendation.

2.04 WALL SLEEVES AND WALL PIPES

A. Where piping passes through concrete structures, furnish and install wall sleeves unless wall pipes or other provisions are specifically shown on the Drawings.

B. Wall Sleeves
1. For pipe sizes smaller than 3-inches, wall sleeves shall be steel oversize sleeves furnished with a full circle, integral or continuously welded waterstop collar. The sleeve seal shall be the mechanically expanded, synthetic rubber type. Provide all associated bolts, seals and seal fittings, pressure clamps or plates necessary to achieve a watertight installation. Sleeves shall extend the full thickness of the concrete. All hardware shall be 316 stainless steel. Sleeves and seal shall be Link Seal.
2. For larger pipe sizes, wall sleeves shall be statically cast ductile iron mechanical joint wall sleeves. Unless specified or shown otherwise for a specific situation, wall sleeves shall be mechanical joint bell-plain end type with waterstop/thrust collar. Sleeves shall be constructed with studs and mechanical joint retainer gland on the air side of the concrete structure.
3. Provide retainer gland where shown on the Drawings. Where the concrete structure is exposed to dirt on one side and is wet on the other side, construct with studs and glands on the dirt side. Wall sleeves shall be equal to ACIPCO A-10771.

C. Wall Pipes
1. Wall pipes shall be either statically cast ductile iron with integral waterstop/thrust collar or centrifugally cast ductile iron with a continuously welded waterstop/thrust collar. The welded-on collar shall be attached to the pipe by the manufacturer. The collar shall be capable of withstanding a thrust force caused by a 250 psi dead end load from either direction on that size pipe. Wall pipes shall be furnished uncoated on the outside and cement lined on the inside.
2. Where shown on the Drawings, provide wall pipes (flange by restrained joint) which shall bolt to a Type C wall thimble provided by the sluice gate manufacturer. Class 125
flanges shall be provided.

3. Wall pipes shall be cast and/or fabricated and lined in one manufacturer's facility and delivered to the job site ready for use.

4. Wall pipe flanges shall be located 9-inches from wall to face of flange unless otherwise noted on the Drawings.

2.05 COATINGS

A. The exterior of pipe and fittings for buried service shall be factory coated with an asphaltic coating conforming to AWWA C151/ANSI 21.51 for ductile iron pipe, AWWA C115/ANSI 21.15 for flanged pipe and AWWA C110/ANSI 21.10 for fittings. Pipe and fittings which shall be exposed or submerged shall be factory coated with a general purpose rust inhibitive primer compatible with the type of paint which will be field applied in accordance with the requirements of Section 09800 of these Specifications.

2.06 PIPE LININGS

A. Cement Linings: Unless shown or specified otherwise, ductile iron pipe and fittings shall be cement lined in accordance with AWWA C104/ ANSI A21.4, standard thickness.

B. Interior Lining: Ductile iron piping and fittings shall be epoxy lined where shown on the drawings.

C. Epoxy Lining:
   1. Linings shall cover all exposed surfaces of pipe and fittings. The lining of the pipe barrel shall extend from spigot end through the socket to the edge of the gasket sealing area or recess for pipe using push-on gaskets, and to the edge of the gasket seat for mechanical joints. The lining shall also cover the exterior of the spigot end from the end of the pipe to beyond the gasket sealing area. The lining in fittings shall cover the interior surfaces including the socket areas as defined above. All linings shall be hermetically sealed at the ends.

   2. Lining Material: The lining material shall be Protecto 401 Ceramic Epoxy, a two component, modified epoxy formulated for corrosion control with the following minimum requirements:
      a. A permeability rating of 0.0 perms when measured by ASTM E 96, Procedure A. Duration of the test shall be six weeks.
      b. A direct impact resistance of 125 inch-pounds with no cracking when measured by ASTM D 2794.
      c. The ability to build at least 50 mils dry in one coat.
      d. The material shall be recoatable with itself for at least seven days with no additional surface preparation when exposed to direct summer sun and a temperature of 90 degrees F.
      e. The material shall contain at least 20 percent by volume of ceramic quartz pigment.
      f. A test and service history demonstrating the ability of the material to withstand the service expected.
      g. Possess a minimum solids volume content of 88 percent, ± one percent.
      h. Possess a maximum drying time to allow recoating as follows: 50 degrees F - 72 hours; 75 degrees F - 18 hours; 90 degrees F - 8 hours. If recoating
cannot be accomplished within seven days, a light brush blast shall be performed to improve intercoat adhesion.

3. Surface Preparation: The interior of the pipe exposed to liquids and gases shall be blasted and cleaned to remove all loose laitance, scale, or other loose material. No lining shall take place over grease, oil, etc., that would be detrimental to the adhesion of the compound to the substrate.

4. Application: The lining shall be applied using a centrifugal lance applicator by workers employed by Vulcan Painters, Inc. The workers shall be experienced and competent in the surface preparation, application and inspection of the lining to be applied. The compound shall not be applied when the substrate temperature is below 40 degrees F or in adverse atmospheric conditions which will cause detrimental blistering, pinholing or porosity of the film.

5. Lining of pipe barrel and fittings shall be 40 mils nominal thickness; minimum lining thickness shall be 30 mils. Lining thickness for exterior of spigot and interior of socket shall be 8 to 10 mils.

6. All pipe and fitting linings shall be tested for pinholes in accordance with ASTM G 62, Method B and shall be holiday free.

7. All pipe linings shall be checked for thickness using a magnetic film thickness gauge.

8. Each pipe joint and fitting shall be marked with the date of application of the lining system and with the numerical sequence of application of that date."

2.07 EXPANSION JOINTS

A. The Expansion Joint shall have a rubber inner tube, a body constructed of multiple piles of fabric impregnated with synthetic rubber, and a protective outer cover of synthetic rubber to provide resistance to deterioration from weather and ozone. Special covers shall be applied when indicated on the drawings to resist weather, ozone, and corrosive fumes. Steel wire shall be imbedded in the body for additional strength.

B. The elastomer and fabric materials shall be determined by the temperature and chemical compatibility requirements, as indicated on the drawings.

1. Class I - to 108°F: PGR, Neoprene, Buna-N, or Hypalon, with Nylon or Polyester reinforcement.
2. Class II - to 250°F: Chlorobutyl, EPDM, or Teflon®-lined, with Polyester reinforcement.
3. Class III - to 400°F: Solid Viton®, with Kevlar® reinforcement.

C. Flanges shall be constructed integrally with the body to resist stresses. Flanges shall be full-pattern so that gaskets are not necessary. Flanges shall be drilled to ANSI B16.5 Class 150#. Flanges shall be accompanied with Galvanized 3/8" split steel retaining rings and enough control rods installed to achieve a working pressure of 200 psi.

D. The expansion joint shall be available with a single arch or multiple arches, in open or filled arch(s) construction, and with wide arch(es) as specified on the drawings. Joint dimensions, movement, and spring rates for all variations shall follow Fluid Sealing Association guidelines.

E. The elastomer construction of the joint acts to absorb vibration, preventing it from being
transmitted to the piping, as well as compensation for lateral deflection. The integral arch allows for axial compression and elongation of the joint, to compensate for expansion and contraction of the piping.

F. All expansion joints shall be Redflex™ Type J-1 as manufactured by the Red alve Company, Inc. of Carnegie, PA 15105 or approved equal.

PART 3 EXECUTION

3.01 CUTTING

A. When new or existing pipe is required to be cut, the pipe shall be cut in such a manner as to leave a smooth end normal to the axis of the pipe.

B. All cutting of ductile iron pipe shall be performed with a cutting saw. All burrs shall be removed from the inside and outside edges of all cut pipe. All damaged linings and coatings shall be repaired.

C. Lining Repair: Repair linings and recoat spigot ends of cut pipe with a product equal to Protecto 101 in accordance with the manufacturer’s recommendations and as specified below:
   1. Remove all burrs and areas of loose lining materials by sanding or scraping to bare metal.
   2. Remove oil and lubricants used during field cutting.
   3. Lining shall be stripped back a minimum of 1-inch from the spigot end into well adhered lined areas.
   4. Roughen 1 to 2-inches of good lining with a rough grade (40 grit) emery paper, rasp or small chisel, to allow an overlap between new and existing lining.
   5. Apply lining repair material in the number of coats required to match the thickness requirements as specified in Part 2 of this Section and in accordance with the manufacturer’s recommendations.

3.02 JOINT ASSEMBLY

A. General: Ductile iron pipe shall be assembled in accordance with ANSI/AWWA C600.

B. Push-On Joints: The inside of the bell and the outside of the pipe from the plain end to the guide stripe shall be wiped clean immediately before assembling the pipe joint. Then the rubber gasket shall be inserted into a groove or shaped recess in the bell. Both the bell and spigot ends to be joined shall be wiped again to ensure they are thoroughly clean. A liberal coating of special lubricant furnished by the pipe manufacturer shall be applied to the outside of the pipe. The plain end shall be centered in the bell and the spigot pushed home.

C. Mechanical Joints
   1. The surfaces with which the rubber gasket comes in contact shall be brushed thoroughly with a wire brush just prior to assembly to remove all loose rust or foreign material which may be present and to provide clean surfaces which shall be brushed with a liberal amount of soapy water or other approved lubricant just prior to slipping
the gasket over the spigot end and into the bell. Lubricant shall be brushed over the gasket prior to installation to remove loose dirt and lubricate the gasket as it is forced into its retaining space.

2. Joint bolts shall be tightened by the use of wrenches and to a tension recommended by the pipe manufacturer. When tightening bolts, the gland shall be brought up toward the pipe bell. If effective sealing is not attained at the maximum torque indicated above, the joint shall be disassembled and reassembled after thorough cleaning. Overstressing of bolts to compensate for poor installation shall not be permitted.

3. After installation, bolts and nuts in buried piping shall be given two heavy coats of a bituminous paint. Bolts and nuts for exposed or submerged service shall be coated in accordance with the requirements of Section 09800 of these Specifications.

D. Flanged Joints
   1. All flanges shall be true and perpendicular to the axis of the pipe. Flanges shall be cleaned of all burrs, deformations, or other imperfections before joining. Flanged joints shall be installed so as to ensure uniform gasket compression. All bolting shall be pulled up to the specified torque by crossover sequence. Where screwed flanges are used, the finished pipe edge shall not extend beyond the face of the flange, and the flange neck shall completely cover the threaded portion of the pipe.
   2. Connections to equipment shall be made in such a way that no torque is placed on the equipment flanges. Connecting flanges must be in proper position and alignment and no external force may be used to bring them together properly.
   3. After installation, bolts and nuts for exposed or submerged service shall be coated in accordance with the requirements of Section 09800 of these Specifications.
   4. Flanged filler shall be used only where shown on the Drawings or approved by the Engineer to make up minor differences in pipe length, less than 3-inches. Joint bolts shall be increased in length by the thickness of the flange filler.

E. Joints of Dissimilar Metals: When a flanged joint consists of a ductile iron flange mated to a steel or alloy flange, the steel flanges shall be flat faced and furnished with full-faced gaskets, insulating bushings.

3.03 DRILLING AND TAPPING

A. Wherever required ductile iron pipe and fittings shall be drilled and tapped to receive drainage or any other piping. All holes shall be drilled accurately at right angles to the axis of any pipe or fitting. Where plugs are drilled, holes shall be at right angles to the face of the plug.

B. Unless shown otherwise, small diameter pipes, less than 2-inches, shall be connected to ductile iron pipe using one of the following methods:
   1. Direct tap.
   2. Direct tap with service saddle.
   3. Direct tap boss.
   4. Tapped plug or flange on tapping saddle.

C. In no case shall the effective number of threads be less than 4.

3.04 CONSTRUCTING BENEATH AND BEYOND STRUCTURES
A. All ductile iron pipes entering buildings or basins shall be adequately supported between the structure and undisturbed earth to prevent damage resulting from settlement of backfill around the structure.

3.05 CONSTRUCTING WITHIN STRUCTURES

A. Proper and suitable tools and appliances for safe and convenient handling and laying of pipe and fittings shall be used. Care shall be taken to prevent the pipe coating from being damaged, particularly cement linings on the inside of the pipes and fittings. Any damage shall be remedied as directed by the Engineer.

B. All pipe and fittings shall be carefully examined by the Contractor for defects just before installing and no pipe or fitting shall be installed if it is defective. If any defective pipe or fitting is discovered after having been installed, it shall be removed and replaced in a satisfactory manner with a sound pipe or fitting by the Contractor at Contractor’s own expense.

C. All pipes and fittings shall be thoroughly cleaned before they are installed and shall be kept clean until they are used in the completed work. Open ends of pipe shall be kept plugged with a bulkhead during construction.

D. All elbows, tees, brackets, crosses, and reducers in pressure piping systems shall be adequately restrained against thrust.

E. Wall pipe and wall sleeves shall be accurately located and securely fastened in place before concrete is poured. All wall pipe and sleeves shall have wall collars properly located to be in the center of the wall where the respective pipes are to be installed. Pipe passing through the sleeve shall extend no more than three feet beyond the structure without a piping joint.

F. Wall pipe and wall sleeves shall be constructed when the wall or slab is constructed. Blocking out or breaking of the wall for later installation shall not be permitted.

G. Cutting or weakening of structural members to facilitate pipe installation shall not be permitted. All piping shall be installed in place without springing or forcing.

H. Exposed ductile iron piping shall be supported as shown on the Drawings and specified.

I. Drilled and tapped bolt hole patterns that are encased in the concrete shall be fully sealed and protected before concrete pours to prevent fouling of the threads.

3.06 FIELD PAINTING

A. Field painting of exposed and submerged pipe shall be in accordance with the requirements of Section 09800 of these Specifications.

3.07 INSPECTION AND TESTING

A. All testing shall be in accordance with the requirements of Testing Section of these Specifications.
3.08 INSULATION AND HEAT TRACING
   A. Provide insulation and heat tracing in accordance with this Section of these Specifications.

3.09 DISINFECTION
   A. Following installation and testing, potable water lines shall be disinfected in accordance with the requirements of Water Pipe and Fittings Section of these Specifications.

3.10 CLEANING
   A. In accordance with this Section of these Specifications.

END OF SECTION
PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Detailed requirements for various 316L Stainless Steel Products. Some products specified in this section may not be required for this Project. Refer to piping system Specification section(s) and Drawings to determine 316L stainless steel piping products to be provided under this Contract.

1.02 SUBMITTALS

A. Product Data:

1. Coating system for surfaces mating to carbon steel. Include coating system submittal information specified in Section 09800.

B. Shop Drawings:

1. Shop Drawings showing layout for 316L stainless steel piping shall be submitted in accordance with and transmitted under appropriate piping system specification sections.

1.03 WELDING QUALIFICATIONS

A. CONTRACTOR shall be responsible for qualifying welders as required by ANSI B31.3 and ASME Boiler and Pressure Vessel Code, Section IX.

B. CONTRACTOR shall maintain record of welding procedures used and welders or welding operators assigned to this Project. Records shall be kept at job site and shall be available to OWNER or ENGINEER on request for duration of Project.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Shipping:

1. Sections with field welded ends shall have wooden plug securely installed at each end to prevent pipes from being bent out of round.

2. Flanged connections shall have plywood blind wired over end and through bolt holes to hold flange against face ring.
3. Ship protected from damage and contact with carbon steel, including steel chain, wire ropes, tools and transport vehicle.

4. Tarp sections during shipment to avoid contact with road dust and salt spray.

B. Storage:

1. Store protected from damage and contact with carbon steel, including steel chain, wire ropes, tools and structural elements.

PART 2 PRODUCT

2.01 PIPE

A. 1/2 in. to 2-1/2 in.:

1. ASTM A312, Grade TP316L (UNS S31603).


3. Wall Thickness:
   a. 1/2 in. to 1-1/2 in.: Schedule 40S.
   b. 2 in. to 2-1/2 in.: Schedule 10S.

B. 3 in. to 36 in.:

1. ASTM A778, Grade TP316L (UNS S31603).


3. Wall Thickness, unless otherwise indicated on the Drawings:
   a. 14 in. to 18 in.: 0.125 in. (11 ga).
   b. 20 in. to 24 in.: 0.140 in. (10 ga).
   c. 30 in. to 36 in.: 0.172 in. (8 ga).

2.02 FITTINGS

A. 1/2 in. to 1 in.:
1. ASTM A403, Class WP, Grade 316L.

2. Dimensions: Conform to ANSI B16.11, threaded or buttwelded, 3,000 lb pressure class.

B. 1-1/4 in. to 2-1/2 in.:

1. ASTM A403, Class WP, Grade 316L.

2. Dimensions: Conform to ANSI B16.9, Buttwelded.

3. Elbows shall be dieform, long radius, smooth flow (pressed type) unless otherwise indicated on Drawings.

4. Wall Thickness: Schedule 10S.

C. 3 in. to 36 in.:

1. ASTM A774, Grade 316L (UNS S31603).

2. Dimensions: Conform to ANSI B16.9, Buttwelded.

3. Elbows 3 in to 18 in inclusive shall be dieform, long radius, smooth flow (pressed type) unless otherwise indicated on Drawings.

4. Elbows 20 in and greater shall be fabricated in 5 mitered sections if 90° and 3 mitered sections if 45°.

5. Wall Thickness: Equal to wall thickness of connected pipe.

2.03 JOINTS

A. Threaded Joints:

1. Size: 1/2 in. to 1 in.

2. Thread Sealant: Teflon tape or Teflon paste.

   a. Oxygen and Ozone gas service: Teflon tape and Teflon paste shall be rated for oxygen service.

B. Flanged Joints:


2. Flange: Mild carbon steel back-up type, faced and drilled to 150 lb class in conformance with ANSI B16.5.
3. Face Ring: Type 316L stainless steel angle ring or flat plate. Flat plate thickness to suit pipe wall thickness and welding procedure to avoid warpage.

4. Bolting: ASTM A307, Grade A, hex head bolts, Class 2A with dimensions in conformance with ANSI B18.2.1, with ASTM A194, Grade 2 or 2H, heavy hex nuts, Class 2B UNC, cadmium plated, with dimensions in conformance with ANSI B18.2.2.

5. Gaskets: Ring-type, PTFE composition, non-asbestos, recommended by gasket manufacturer as suitable for service, similar to Garlock "Gylon" style.
   
   a. Oxygen and Ozone gas service: gaskets shall be rated for oxygen service, oxygen cleaned, shipped and stored bagged and sealed to prevent contamination.

2.04 SHOP FABRICATION

A. Dimensions:

1. Piping dimensions of fabricated sections shall conform to dimensions for manufactured pipe in ANSI B36.19.

2. For purpose of shop fabrication, dimensions shown on Drawings shall be considered approximate only. Field verification is responsibility of CONTRACTOR. Where possible, use field welds in each direction with adequate allowance for trim and fit, but not less than 2 in. in each direction. Loose flanged shall be provided for fit up at equipment connections.

B. Branch Connections:

1. Nozzle welds may be used in lieu of buttwelded reducing tees when permitted by ANSI B31.3. Buttwelded tees shall be used when branch is same size or one pipe size smaller than header. Nozzle welds shall be reinforced in conformance with ANSI B31.3.

2. Threaded full couplings may be used for branch connections of 1 in. or smaller pipe size. Coupling shall comply with Paragraph 2.03A.

C. Shop Welded Joints:

1. Preparation: Equipment used in welding preparation shall be covered or faced to prevent mild steel contamination of stainless steel. Items shall be marked "STAINLESS STEEL", and shall be used for no other purpose.

2. Cleaning: Clean metal to be fused of lubricants, grease, paint, filings, and cuttings. Cleaning with alcohol or acetone. Do not use chlorinated solvents.

3. MIG and TIG Welding: Metal Inert Gas (MIG) welding may be used with automatic or semi-automatic machine welding. Tungsten Inert Gas (TIG) welding shall be used for manual
4. SMA Welding: Shielded Metal Arc (SMA) welding may be used at noncritical non-pressure connections and for joining stainless to carbon steel. Welding electrodes shall be stored in dry atmosphere to avoid moisture pick-up. Filler metal rods shall be AWS A5.4 Type E316L.

5. Dissimilar Metals: Do not weld carbon steel directly to stainless steel piping. Weld "poison pads" of equal thickness and same material of pipe to pipe and attach carbon steel to poison pad. SMA welding may be used to attach carbon steel to stainless pad. Filler metal rods shall be AWS A5.4 Type E309, or ASW A5.9 Type ER309 if TIG welding is used.

6. Shielding Gas: Use welding grade argon or helium-argon mixture.

7. Penetration: Buttweld joints shall have 100% penetration.

8. Tack Welding: Make tack welds with same grade of filler metal as finished weld. Tack welds shall be small enough to be absorbed into following weld beads and have slag and oxides removed prior to finishing weld or be completely removed.

9. Weld Finish: Inside of weld shall be smooth and free from projections and depressions. Grind with iron free grinding wheels labeled "STAINLESS STEEL" used for nothing else. Use 160 grit grinding wheels. Remove scale, oxides, and discolorations from pipes and welds. Products and procedures shall be as recommended by manufacturer.

10. All pipe, fittings and other components shall be immersed in a pickling solution of 6-10% nitric acid and 3-4% hydrofluoric acid in the manufacturer’s plant. Temperature and exact concentrations shall be such that only a modest etch is produced while removing all oxidation and ferrous contamination from the stainless steel surface. All residues of pickling solution shall be completely neutralized after pickling.

D. Identification: Fabricated pipe sections shall have line and spool number painted on each section. Line and spool numbers shall agree with Shop Drawings.

2.05 COATING

A. Surface preparation, priming, and finish coating of carbon steel surfaces shall be compatible and in accordance with Section 09880 as follows:

1. Dissimilar metal protection: 14-C.
A. Install in accordance with approved submittals and manufacturer's written instructions.

B. Install in accordance with appropriate piping system Specification section.

3.02 FIELD WELDED JOINTS

A. Branch Connections:

1. Nozzle welds may be used in lieu of buttwelded reducing tees when permitted by ANSI B31.3. Use buttwelded tees when branch is same size or one pipe size smaller than header. Reinforce nozzle welds in conformance with ANSI B31.3.

2. Threaded full couplings may be used for branch connections of 1-in. or smaller pipe size. Couplings shall comply with Paragraph 2.03.A.

B. Joint Preparation:

1. Equipment used in welding preparation shall be covered or faced to prevent mild steel contamination of stainless steel. Items shall be marked "STAINLESS STEEL" and used for no other purpose.


3. Cleaning: Clean metal to be fused of lubricants, grease, paint, filings, and cuttings. Cleaning with alcohol or acetone. Do not use chlorinated solvents.

C. Welding:

1. Protect weld area from wind or draft while welding with gas back-up.

2. Preheat weld area if work piece temperature is less than 60_F.

3. TIG Welding: Use Tungsten Inert Gas (TIG) welding for welding of pressure joints. Apply shielding gas protection to underside of weld. Filler metal rods shall be AWS A5.9 Type ER316L.

4. SMA Welding: Shielded Metal Arc (SMA) welding may be used at noncritical non-pressure connections and for joining stainless to carbon steel. Welding electrodes shall be stored in dry atmosphere to avoid moisture pick-up. Filler metal rods shall be AWS A5.4 Type E316L.

5. Dissimilar Metals: Carbon steel shall not be welded directly to stainless steel piping. Weld "poison pads" of equal thickness and same material of pipe to pipe and attach carbon steel to poison pad. SMA welding may be used to attach carbon steel to stainless pad. Filler metal rods shall be AWS A5.4 Type E309, or ASW A5.9 Type ER309 if TIG welding is used.
6. Shielding Gas: Use welding grade argon or helium-argon mixture.

7. Penetration: Buttweld joints shall have 100% penetration.

8. Tack Welding: Make tack welds with same grade of filler metal as finished weld. Tack welds shall be small enough to be absorbed into following weld beads and have slag and oxides removed prior to finishing weld or be completely removed.

9. Weld Finish: Inside of weld shall be smooth and free from projections and depressions. Grind with iron free grinding wheels labeled "STAINLESS STEEL" used for nothing else. Use 160 grit grinding wheels. Remove scale, oxides, and discolorations from pipes and welds. Products and procedures shall be as recommended by manufacturer.

10. All field welds shall be treated with a pickling paste, scrubbed and washed until clean with stainless steel wire brushes. All residues of pickling paste shall be completely neutralized after pickling.

D. Coating:

1. Coat both faces of flanges mating with carbon steel with System 14-C.

*** END OF SECTION ***
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Work covered under this Section consists of providing hangers and supports for equipment and piping systems.

1.3 DEFINITIONS AND REFERENCES

A. Definition:

1. Wetted or Submerged: Submerged, less than one foot above liquid, below top of channel wall, under cover or slab of channel or tank, or in other damp locations.

B. References:

1. American Welding Society (AWS):
   a. D1.1 – Structural Welding Code-Steel
   b. D1.2 - Structural Welding Code-Aluminum
   c. D1.6 - Structural Welding Code-Stainless Steel

2. American Society of Mechanical Engineers:
   a. B31.9-Standard Building Services Piping
   b. Section IX, Boiler and Pressure Vessel Code: Welding and Brazing Qualifications

3. ASTM International (ASTM):
   b. A 36-Standard Specifications for Carbon Structural Steel
c. A 123 – Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

d. A 183 – Specification for Carbon Steel Track Bolts and Nuts

e. A 525 – Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.

f. A 653 – Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

g. A 780 – Practice for Repair of Damaged and Uncoated Areas of Hot-Dip galvanized Coatings.

h. 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

i. C 1107 – Specification for Packaged Dry Hydraulic Cement (Non-Shrink)

j. F 844 – Specification for Washers, Steel, Plain (Flat), Unhardened for General Use Only

4. Manufacturers Standardization Society (MSS):

a. SP-58 Pipe Hangers and Supports-Materials, Design and Maintenance

b. SP-69 Pipe Hangers and Supports-Selection and Application

c. SP-89 Pipe Hangers and Supports-Fabrication and Installation Practices

d. SP-127 Bracing for Piping Systems Seismic-Wind-Dynamic Design, Selection, Application

5. NFPA (National Fire Protection Association):

a. NFPA 13 – Standard for the Installation of Sprinkler Systems

b. NFPA-14 - Standard for the Installation of Standpipes and Hose Systems

c. NFPA 70 - National Electrical Code

1.4 SYSTEM DESCRIPTION

A. Engineered Hanger and Support System: The Contractor shall provide an engineered
hanger and support system for the various piping systems indicated on the Drawings. This includes the design of multiple piping supports and trapeze hangers and the selection of appropriate hangers and anchors to the structures, buildings, and facilities. This design shall be accomplished by a professional engineer license in the state where the Project is to be constructed.

B. Codes and Standards:

1. Regulatory Requirements: Comply with applicable plumbing codes pertaining to product materials and installation of the hanger and support system.

2. NFPA Compliance: Hanger and support system shall comply with NFPA -13 when used as a component of a fire protection system and NFPA-14 when used as a component of a standpipe system.

3. UL and FM Compliance: Hanger and support system components shall be listed and labeled by UL and FM when used for fire protection systems.

4. National Recognized Testing Laboratory and NEMA Compliance (NRTL): Instead of UL and FN compliance, the hanger and support system components shall be listed and labeled by a NTRL where used for fire protection systems. The term “NTRL” shall be as defined in OSHA Regulation 1910.7.

5. Duct Hangers: SMACNA Duct Manuals.

6. MSS Standard Compliance: Provide hanger and support system components of which materials, design, and manufacture comply with MSS SP-69.

C. Design Requirements:

1. General:

   a. The configuration and layout of yard and station piping systems are shown in the Drawings.

   b. In certain locations, pipe supports, anchors, and expansion joints have been indicated on the drawings, but no attempt has been made to indicate every pipe support, anchor, and expansion joint.

   c. It shall be the Contractor’s responsibility to provide a complete system of pipe supports, to provide expansion joints, and to provide restraints and anchor all piping, in accordance with the requirements set forth herein.

   d. Additional pipe supports may be required adjacent to expansion joints, couplings, flanged connections, or valves.
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e. Piping Smaller than 30 Inches: Supports are shown only where specific
types and locations are required; provide additional pipe, valve, and
equipment supports as required.
f. Piping 30 inches and Larger: Support systems have been designed for
piping and shall be placed at the designated locations as shown on the
Drawings.
g. Comply with the requirements of MSS SP-58, MSS SP-69, and MSS SP-
89.

2. Piping Support Systems:

a. Support Load: Dead loads imposed by weight of pipes filled with water,
except air and gas pipes, plus insulation.

Rod Size:

1) Steel or Ductile Iron Piping:

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Maximum Support/Hanger Spacing</th>
<th>Minimum Rod Size Single Rod Hangers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-inch and smaller</td>
<td>6 feet</td>
<td>1/4-inch</td>
</tr>
<tr>
<td>1-1/2-inch thru 2-1/2-inch</td>
<td>8 feet</td>
<td>1/4-inch</td>
</tr>
<tr>
<td>3-inch &amp; 4-inch</td>
<td>10 feet</td>
<td>3/8-inch</td>
</tr>
<tr>
<td>6-inch</td>
<td>12 feet</td>
<td>3/8-inch</td>
</tr>
<tr>
<td>8-inch</td>
<td>12 feet</td>
<td>1/2-inch</td>
</tr>
<tr>
<td>10-inch &amp; 12-inch</td>
<td>14 feet</td>
<td>5/8-inch</td>
</tr>
<tr>
<td>14-inch</td>
<td>16 feet</td>
<td>3/4-inch</td>
</tr>
<tr>
<td>16-inch &amp; 18-inch</td>
<td>16 feet</td>
<td>7/8-inch</td>
</tr>
<tr>
<td>20-inch</td>
<td>18 feet</td>
<td>1-inch</td>
</tr>
<tr>
<td>24-inch</td>
<td>18 feet</td>
<td>1-1/4-inch</td>
</tr>
<tr>
<td>30-inch and larger</td>
<td>As shown on Drawings</td>
<td>As shown on Drawings</td>
</tr>
</tbody>
</table>

2) Copper Piping:

a) Maximum Support Spacing: Two (2) feet less per size
than listed for steel, with 1-inch and smaller pipe
supported every five (5) feet.
HANGERS AND SUPPORTS
FOR PIPING SYSTEMS

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b) Minimum Hanger Rod Size: Same as listed for steel pipe.

3) Plastic and Fiberglass Piping:
   a) Maximum Support Spacing: As recommended by manufacturer for flow and temperature in pipe.
   b) Minimum Rod Sizing: Same as listed for steel pipe.
   c) Provide supports with width as required by pipe manufacturer and shields as required to protect pipe in accordance with manufacturer’s requirements.
   d) Stainless Steel Piping:

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Maximum Support/Hanger Spacing</th>
<th>Minimum Rod Size Single Rod Hangers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-inch thru 4-inch</td>
<td>8 feet</td>
<td>1/4-inch</td>
</tr>
<tr>
<td>6-inch</td>
<td>8 feet</td>
<td>3/8-inch</td>
</tr>
<tr>
<td>8-inch &amp; 10-inch</td>
<td>10 feet</td>
<td>1/2-inch</td>
</tr>
<tr>
<td>12-inch</td>
<td>10 feet</td>
<td>1/2-inch</td>
</tr>
<tr>
<td>14-inch &amp; 16-inch</td>
<td>12 feet</td>
<td>5/8-inch</td>
</tr>
<tr>
<td>18-inch &amp; 20-inch</td>
<td>14 feet</td>
<td>7/8-inch</td>
</tr>
<tr>
<td>24-inch</td>
<td>14 feet</td>
<td>7/8-inch</td>
</tr>
</tbody>
</table>

3. Framing Support Systems:
   a. Beams: Size such that beam stress does not exceed 25,000 psi and maximum deflection does not exceed 1/240 of span.
   b. Column Members: Size in accordance with manufacturer’s recommended method.
   c. Support Loads: Calculate using weight of pipes filled with water.
   d. Maximum Spans:
      1) Steel and Ductile Iron Pipe, 3-Inch Diameter and Larger: 10-foot centers, unless otherwise shown.
      2) Other Pipelines and Special Situations: May require
supplementary hangers and supports.

e. Electrical Conduit Support: Include in design of framing support systems.

4. Anchoring Devices: Design, size, and pace support devices, including anchor bolts, inserts, and other devices used to anchor support, to withstand shear and pullout loads imposed by loading and spacing on each particular support.

5. Vertical Sway Bracing: 10-foot maximum centers, or as shown.

6. Existing Support Systems: use existing support systems to support new piping only if Contractor can show that they are adequate for the additional loads, or if they are strengthened to support the additional load.

1.5 SUBMITTALS

A. Product Data:

1. Product data to include, but not be limited to materials, finishes, testing agency approvals, load ratings, and dimensional information.

2. Provide installation instructions for each type of hanger and support.

3. Submit pipe hanger and support schedule showing manufacturer's Figure No., size, location, and features for each required pipe hanger and support.

B. Shop Drawings: Provide for each type of hanger and support, indicating dimensions, weights, required clearances, and methods of component assembly. Indicate all loads exceeding 250 lbs imposed on building support systems and on structures.

C. Informational Submittals:

1. Welder certificates signed by Contractor certifying that welders comply with requirements specified under the “Quality Assurance” Article.

2. Product certificates signed by manufacturer certifying that their product meet the specified requirements.

1.6 QUALITY ASSURANCE

A. Welding:

1. Qualify welding processes and welding operators according to the following codes depending on the material welded.

   a. AWS D1.1 "Structural Welding Code--Steel."

HANGERS AND SUPPORTS
FOR PIPING SYSTEMS

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b. AWS D1.2 "Structural Welding Code-Aluminum."

c. AWS D1.6 "Structural Welding Code-Stainless Steel."

2. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

B. Qualify welding processes and welding operators according to ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications."

C. NFPA Compliance: Comply with NFPA 13 for hangers and supports used as components of fire protection systems.

D. Listing and Labeling: Provide hangers and supports that are listed and labeled as defined in NFPA 70, Article 100.

1. UL and FM Compliance: Hangers, supports, and components include listing and labeling by UL and FM where used for fire protection piping systems.

2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

E. Licensed Operators: Use operators that are licensed by powder-operated tool manufacturers to operate their tools and fasteners.

1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Comply with the requirements of the General Conditions and manufacturer's recommendations.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. General:

1. When specified items are not available, fabricate pipe supports of correct material and to general configuration indicated in catalogs.

2. Special supports and hangers details will be required for cases where standard catalog supports are inapplicable.

3. Materials: Unless otherwise shown on the Drawings, fabricate supports using the following materials:
DUNDEE STATE FISH HATCHERY OZONE SYSTEM
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a. Wetted and Submerged: Type 316 Stainless Steel.
b. Atmospheric Exposed: Type 316 Stainless Steel.
c. Hardware: Type 316 Stainless Steel.

B. Hangers, Supports, and Components:

1. Selection and application of pipe hangers and supports for all service temperatures shall be in accordance with MSS SP-69.

2. Requirements for material, design and manufacture of standard types of hanger and support system components shall be in accordance with MSS SP-58.

3. Requirements for the fabrication and installation of the hanger and support system shall be in accordance with MSS SP-89.

4. Requirements relating to the design, selection, and applications of bracing for piping systems subject to seismic-wind-dynamic loading shall be in accordance with MSS SP-127.

5. Components include galvanized coatings where installed for piping and equipment that will not have a field-applied finish.

6. Pipe attachments shall include a nonmetallic coating for electrolytic protection where attachments are in direct contact with copper pipe and tubing.

C. Products:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

   a. ANVIL International, Inc.

   b. Cooper B-Line, Inc.

   c. National Pipe Hanger Corporation

   d. Piping Technology & Products, Inc.

2.2 HANGERS

A. Adjustable Clevis Hanger: MSS SP-58, Type 1.

B. Adjustable Swivel Ring for Non-Insulated Pipe: MSS Type 7.

C. Hinged Split-Ring Pipe Clamp: MSS SP-58, Type 6 or 12.
D. Yoke and Roller Hanger: MSS Type 41 and 43.

E. U-Bolts: MSS Type 24.

F. Straps: Mss Type 26.

G. Anchor Rods, Clevises, Nuts, Sockets, and Turnbuckles: In accordance with MSS SP-58.

H. Attachments:
   1. I-Beam Clamp: Concentric loading type, MSS SP-58, Type 21, 28, 29, or 30, which engage both sides of flange.
   2. Concrete Insert: MSS SP-58, Type 18, continuous channel insert with load rating not less than that of hanger rod it supports.

2.3 PIPE SUPPORTS

A. Pedestal Type: Schedule 40 pipe stanchion, saddle, and anchoring flange.
   1. Nonadjustable Saddle: MSS SP-58, Type 37 with U-bolt.
   2. Adjustable Saddle: MSS SP-58, Type 38 without clamp.

B. Pipe Stanchion: Anvil Figure 62 and 63 for support of steel pipe elbows, horizontal pipe, and for use with pipe saddles.

2.4 ROLLERS AND ROLLER SUPPORTS

A. Roller with Adjustable Support Stand:
   1. Designed for pipe support where longitudinal movement and vertical adjustment is required.
   2. Non-metallic roller with stainless steel stand and hardware.
   3. Complies with MSS SP-69 and SP-58, Type 46.

B. Roller with Non-Adjustable Support Stand:
   1. Designed for supporting pipe with longitudinal movement.
   2. Non-metallic roller with stainless steel chair, stand and hardware.
   3. Complies with MSS SP-69 and SP-58, Type 44.
C. Roller with Ceiling Suspended Supports:
   1. Designed for suspending pipe where longitudinal movement and vertical adjustment is required.
   2. Steel with cast iron roller, standard finish.
   3. Complies with MSS SP-69 and SP-58, Type 43 or Type 41.

2.5 WALL SUPPORTS

A. Horizontal Pipe:
   1. 1/4-Inch Thru 4 Inches: Offset or straight J-hook.
   2. 4 Inches and Greater: Welded steel bracket MSS Type 31, 32, or 33 and wrought steel clamp. Provide adjustable steel yoke and cast iron roll MSS Type 44 for hot pipe 2000 F and over and for sizes 6 inches and greater.

B. One-Hole Clamp: Anvil; Figure 126.

C. Channel Type: Unistrut, Anvil, Cooper B-Line.

2.6 PIPE CLAMPS

A. Riser Clamp: MSS SP-58, Type 4.

B. Flexibility in hanger assembly required due to horizontal movement, use pipe clamps with weldless eye nuts: MSS SP-58, Type 4, with Type 17. For insulated lines use double bolted pipe clamps: MSS SP-58, Type 3, with Type 17.

C. Offset Pipe Clamp: Galvanized carbon steel clamp for use is supporting piping away from floor or wall; Anvil Figure 103 or equivalent.

D. Extension Pipe or Riser Clamp: Galvanized carbon steel riser clamp for support of vertical piping complying with MSS SP-69 and MSS-58, Type 8 and Type 42. Type 42 is designed also to be supported by hanger rods.

2.7 MULTIPLE OR TRAPEZE HANGERS

A. Trapeze hangers constructed from 12 gauge roll formed ASTM A1011 SS Gr. 33 structural steel channel, 1-5/8-inch x 1-5/8-inch minimum.

B. Mount pipes to trapeze with two piece pipe straps sized for outside diameter of pipe. Pipes subject to axial movement:
1. Use strut mounted roller supports; use pipe protection shield or saddles on FRP and insulated lines.

2. Use strut mounted pipe guide as required.

2.8 CHANNEL TYPE SUPPORT SYSTEMS

A. Steel Construction:

1. Channel: Pre-galvanized in accordance with ASTM A525, Class G90, or hot-dip after fabrication.

2. Hardware: Type 316 stainless steel.

3. Channel Size:
   a. Single Channel: 14-gauge, 1-5/8" by 1-5/8".
   b. Double Channel: 14-gauge, 3-1/4" by 1-5/8".
   c. Manufacturer: Unistrut Series P1000 or equivalent.


B. Fiberglass Construction:

1. Channel: Polyester and vinylester reinforce with multiple strands of glass filament, UV resistant surfacing veils channels.
   b. Double Channel: Heavy duty 3-1/4" by 1-5/8”; Unistrut Series F20V-2100.

2. Seal all cut ends with a clear sealer and provide end caps on exposed ends after assembly.

3. Hardware: Fiberglass or stainless steel.

C. Available Manufactures:
1. Anvil; Power-Strut Line
2. Cooper B-Line
3. National Pipe Hangers Corporation
4. Unistrut Corporation

2.9 ACCESSORIES

A. Protection Shields: MSS Type 40; galvanized steel or stainless steel, 180 degrees arc, minimum 12 inches long, to prevent crushing insulation.

B. Protection Saddles: MSS Type 39; fill interior with segments of insulation matching adjoining insulation.

C. Thermal Shields:
   1. Provide 100-psi minimum compressive strength, waterproof, asbestos free calcium silicate, encased with a sheet metal enclosure. Insert and shield shall cover the entire circumference or the bottom half circumference of the pipe, with length recommended by the manufacturer for pipe size and thickness of insulation.
   2. Cold Piping: Calcium silicate shall extend beyond the sheet metal shield allowing overlap of vapor barrier.
   3. Piping, 4 inches and larger, supported on trapeze or pipe rollers, provide double thickness shields.
   4. Piping, 12 inches and greater, provide 600 psi calcium silicate structural insert.

D. Vibration Isolation and Supports:
   1. For refrigeration, air conditionings, hydraulic, pneumatic, and other vibrating system applications, use a clamp that has a vibration dampening inserts and a nylon inserted locknut. For copper and steel tubing use Cooper B-Line BVT series VibraClamps, for pipe sizes use BVP series, or equivalent.
   2. For larger tubing or piping subjected to vibration, use neoprene or spring hangers as required. For spring hangers use Mason or equal.
   3. For base mounted equipment use vibration pads, molded neoprene mounts, or spring mounts as required.
   4. Vibration isolation products as manufactured by Cooper B-Line, VibraTrol systems, or equivalent.
E. Intermediate Pipe Guides:

1. Piping, 6 inches and smaller:
   a. Type: Pipe clamp with oversized pipe sleeve to provide minimum 1/8-inch clearance.

2. Piping, 8 inches and larger:
   a. Type: Specially formed U-bolts with double nuts to provide 1/4-inch minimum clearance around pipe.
   b. U-Bolt Stock Size:
      1) 8-inch Pipe: 5/8-inch
      2) 10-inch Pipe: 3/4-inch
      3) 12-inch through 16-inch Pipe: 7/8-inch
      4) 18-inch through 30-inch Pipe: 1-inch

F. Pipe Alignment Guides:

1. Piping 8 inches and Smaller: Spider of sleeve type.

2. Piping 10 inches and Larger: Roller type.

G. Pipe Anchors:

1. Type: Anchor chair with U-bolt.

H. Hangers shall be threaded at either end or continuous threaded rods of circular cross section. Use adjusting locknuts at upper attachments and hangers. No wire, chain, or perforated straps are allowed.

2.10 MISCELLANEOUS MATERIALS

A. Hanger Support Anchors: Comply with the manufacturer’s recommendations for cast-in-place anchors, concrete and masonry drilled anchors, and material of construction for anchors based on the environment.

1. Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used. Fasteners for fire protection systems include UL listing and FM approval.
B. Powder actuated fasteners and other types of bolts and fasteners not specified herein shall not be used unless approved by the Engineer.

1. Powder-actuated-type, drive-pin attachments with pull-out and shear capacities appropriate for supported loads and building materials where used. Fasteners for fire protection systems include UL listing and FM approval.

C. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars, black and galvanized.

D. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel, hex-head, track bolts and nuts.

E. Washers: ASTM F 844, steel, plain, flat washers.

F. Grout: ASTM C 1107, Grade B, nonshrink and nonmetallic;

1. Characteristics include post-hardening, volume-adjusting, dry, hydraulic-cement-type grout that is nonstaining, noncorrosive, nongaseous and is recommended for both interior and exterior applications.

2. Design Mix: 5000-psi, 28-day compressive strength.


PART 3 - EXECUTION

3.1 PREPARATION

A. Examine areas and conditions under which the hanger and support system will be installed. Do not proceed with work until satisfactorily conditions have been corrected in manner acceptable to installer.

B. Proceed with installation of the hanger and support system only after required structural work has been completed in areas where work is to be installed. Correct inadequacies including, but not limited to. Proper placement of inserts, anchors, and other structural attachments. Review Drawings to obtain structural support limitations.

3.2 HANGER AND SUPPORT INSTALLATION

A. General: Comply with MSS SP-69 and SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Channel Support Installation: Arrange for grouping of parallel runs of horizontal piping supported together on field-fabricated, heavy-duty trapeze hangers where possible.
1. Field assemble and install according to manufacturer’s instructions.

C. Heavy-Duty Steel Trapezes: Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricate heavy-duty trapezes.

   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install support intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.

   2. Field-fabricate from ASTM A36 steel shapes selected for loads being supported.

   3. Weld steel according to AWS D-1.1.

D. Install building attachments within concrete or to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert to forms. Install reinforcing bars through openings at top of inserts.

E. Install powder-actuated drive-pin fasteners 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. Do not use in lightweight concrete slabs or in concrete slabs less than 4 inches thick.

F. Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install according to fastener manufacturer’s written instructions. Do not use in lightweight concrete slabs or in concrete slabs less than 4 inches thick.

G. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

H. Support fire protection systems piping independent of other piping.

I. Install hangers and supports to allow controlled movement of piping systems, permit freedom of movement between pipe anchors, and facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

J. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.

K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so that maximum pipe deflections allowed by ASME B31.9 "Building Services Piping" is not exceeded. Insulated Piping: Comply with the following installation requirements.

   1. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting
through insulation; do not exceed pipe stresses allowed by ASME B31.9.

2. Saddles: Install protection saddles MSS Type 39 where insulation without vapor barrier is indicated. Fill interior voids with segments of insulation that match adjoining pipe insulation.

3. Shields: Install MSS Type 40, protective shields on cold piping with vapor barrier. Shields span an arc of 180 degrees and have dimensions in inches not less than the following:

<table>
<thead>
<tr>
<th>NPS (Inches)</th>
<th>Shield Length (Inches)</th>
<th>Shield Thickness (Inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/4 to 3-1/2</td>
<td>12</td>
<td>0.048</td>
</tr>
<tr>
<td>4</td>
<td>12</td>
<td>0.060</td>
</tr>
<tr>
<td>5 and 6</td>
<td>18</td>
<td>0.060</td>
</tr>
<tr>
<td>8 to 14</td>
<td>24</td>
<td>0.075</td>
</tr>
<tr>
<td>16 to 24</td>
<td>24</td>
<td>0.105</td>
</tr>
</tbody>
</table>

4. Pipes 8 Inches (200 mm) and Larger: Include wood inserts.

5. Insert Material: Length at least as long as the protective shield.

6. Thermal-Hanger Shields: Install with insulation of same thickness as piping.

L. Piping Support General Applications:

1. Support piping connections to equipment by pipe support and not by the equipment.

2. Support large or heavy valves, fittings, and appurtenances independently of connected piping.

3. Do not support one pipe from another.

4. Support pipe at changes in direction or in elevation, adjacent to flexible joints and couplings, and where shown.

5. Do not install pipe supports and hangers in equipment access areas or bridge crane runs.

6. Brace hanging pipes against horizontal movement by both longitudinal and lateral sway bracing.

7. Install pipe anchors where required to withstand expansion thrust loads and to direct and control thermal expansion.
8. Repair mounting surfaces to original condition after attachments are made.

M. Standard Pipe Supports:

1. Horizontal Suspended Piping:
   b. Grouped Pipes: Trapeze hanger systems.
   c. Furnished galvanized steel protection shield and oversized hangers for all insulated pipes.
   d. Furnish precut sections of rigid insulation with vapor barrier at hangers for all insulated pipe.

2. Horizontal Piping Supported from Walls:
   a. Single Pipes: Wall brackets or wall clips attached to wall with anchors. Clips attached to wall mounted framing also acceptable.
   b. Stacked Piping:
      1) Wall mounted framing system and clips acceptable for piping smaller than 3-inch nominal diameter.
      2) Piping clamps which resist axial movement of pipe through support not acceptable.
   c. Wall mounted piping clips not acceptable for insulated piping.

3. Horizontal Piping Supported From Floors:
   a. Stanchion Type:
      1) Pedestal type; adjustable with stanchion, saddle, and anchoring flange.
      2) Use yoked saddles for piping whose centerline elevation is 18 inches or greater above the floor and for all exterior installations.
      3) Provide neoprene waffle isolation pad under anchoring flanges, adjacent to equipment or where otherwise required to provide vibration isolation.
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b. Floor Mounted Channel Supports:
   1) Use for piping smaller than 3-inch nominal diameter running along floors and in trenches at piping elevations lower than can be accommodated using pedestal pipe supports.
   2) Attach channel framing to floors with anchor bolts.
   3) Attach pipe to channel framing with clips or pipe clamps.

c. Concrete Cradles: Use for piping larger than 3-inch nominal diameter along floor and in trenches at piping elevations lower than can be accommodated using stanchion type.

4. Vertical Pipe: Support with wall brackets and base elbow or riser clamps on floor penetrations.

5. Standard Attachments:
   a. To Concrete Ceilings: Concrete inserts.
   b. To Steel beams: I-beam clamps or welded attachments.
   c. To Wooden Beams: Lag screws and angle clips to members with anchor bolts.
   d. To Concrete Walls: Concrete inserts or brackets or clip angles with anchor bolts.

6. Existing Walls and Ceilings: Install as specified unless otherwise shown.

N. Intermediate and Pipe Alignment Guides:
   1. Provide pipe alignment guides (or pipe supports that accomplishes the same function) at all expansion joints and loops.
   2. Guide piping on each side of an expansion joint or loop at four to fourteen pipe diameters distance from each joint or loop.
   3. Install intermediate guides on metal framing support systems not carrying a pipe anchor or alignment guide.

O. Accessories:
   1. Insulation Shield: Install on insulated non-steel piping. Oversized rollers and supports.

3. Vibration Isolation Pad: Install under base flange of pedestal type pipe supports adjacent to equipment, and where required to isolate vibration.

4. Dielectric Barrier:
   a. Install between carbon steel members and copper or stainless steel pipe.
   b. Install between stainless steel supports and nonstainless steel ferrous metal piping.

5. Electrical isolation: Install 1/4-inch by 3-inch neoprene rubber wrap between submerged metal pipe and oversized clamps.

P. Piping and ductwork supports are to be independent supports and directly supported from building or structure. Combining supports from more than one trade is not permitted.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural steel stands to suspend equipment from structure above or support equipment above floor.

B. Grouting: Place grout under supports for equipment, and make a smooth bearing surface.

3.4 METAL FABRICATION

A. Cut, drill, and fit miscellaneous metal fabrications for pipe 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 procedures for manual shielded metal-arc welding, appearance and quality of welds, methods used in correcting welding work, and the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Finish welds at exposed connections so that no roughness shows after finishing,
and so that contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

3.6 PAINTING

A. Touching Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal is specified in Section 09800.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

3.7 VIBRATION

A. Vibration of the piping system during operation is not acceptable.

B. Contractor shall provide additional lateral supports as required to eliminate piping vibration at no addition cost to OWNER.

END OF SECTION
PART 1 - GENERAL

1.1 SECTION INCLUDES
A. The work to be performed under this section of the specifications shall include:
   1. Furnishing and installation of sump pumps as shown in the plans.
   2. Furnishing and installation of all necessary bracket, bearings, bushings, attachments and necessary appurtenances required for proper and intended operation.

1.2 RELATED SECTIONS
A. UGC Article 8 – Quality Control; Submittals

1.3 SUBMITTALS
A. Submit in accordance with UGC Article 8 – Quality Control; Submittals
B. Manufacturer's Literature and Data:
   1. Pump:
      a. Manufacturer and model.
      b. Operating speed.
      c. Capacity.
      d. Characteristic performance curves.
   2. Motor:
      a. Manufacturer
      b. Speed.
      d. Efficiency.
C. Complete operating and maintenance manuals including wiring diagrams, technical data sheets and information for ordering replaceable parts:
   1. Include complete list which indicates all components of the system.
   2. Include complete diagrams of the internal wiring for each item of equipment.
   3. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.
PART 2 PRODUCTS

2.1 SUMP PUMP

A. Submersible pump and motor designed for 65 degrees C (150 degrees F) maximum water service. Driver shall be electric motor. Support shall be rigid type. Provide perforated, suction strainer. Documents Pumps shall be capable of continuous duty cycle.

1. Pump housings may be cast iron or stainless steel. Cast iron and aluminum housings for submersible pumps shall be epoxy coated.

B. Impeller: Cast iron.

C. Shaft: Stainless steel or other approved corrosion-resisting metal.

D. Bearings: As required to hold shaft alignment, anti-friction type for thrust permanently lubricated.

E. Motor: Maximum 40 degrees C (104 degrees F) ambient temperature rise above the maximum fluid temperature being pumped, completely enclosed voltage and phase conforming to NEMA 250 -Type 6P. Motor capacity to be ¾ hp, 230V, single phase.

F. Starting Switch: Manually-operated, tumbler type,

G. Level Control: Integrated and adjustable vertical float switches

H. Sump: Furnish RCP for the sump depth

PART 3 - EXECUTION

3.1 STARTUP AND TESTING

A. Make tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.

3.2 OPERATION AND MAINTENANCE MANUALS

A. Provide six operation and maintenance manuals.

3.3 WARRANTY

A. The manufacturer shall guarantee for one years from the date of the Certificate of Final Completion that the equipment will be free from defects of all kinds including application,
design, materials, and workmanship. A full written parts and service type warranty shall be provided for this one year time period.

3.4 DEMONSTRATION AND TRAINING

A. Provide services of manufacturer's technical representative for four hours to instruct TPWD Personnel in operation and maintenance of units.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES

A. Piping insulation for small diameter water lines and chemical supply lines.

B. Jackets and accessories.

1.2 REFERENCES


W. NAIMA National Insulation Standards.


1.3 SUBMITTALS FOR REVIEW

A. UGC Article 8 – Quality Control; Submittals

B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

B. Applicator Qualifications: Company specializing in performing the work of this section with minimum five (5) years documented experience.

1.5 REGULATORY REQUIREMENTS

A. Conform to maximum flame spread/smoke developed rating of 25/50 in accordance with ASTM E84, NFPA 255 and UL 723.

1.6 DELIVERY, STORAGE, AND PROTECTION

A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient conditions required by manufacturers of each product.

B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 PRODUCTS

2.1 GLASS FIBER

A. Insulation: ASTM C547 [and ASTM C795]; rigid molded, noncombustible.

1. ‘K’ value: ASTM C177, 0.24 at 75 degrees F.

2. Maximum service temperature: 850 degrees F.

3. Maximum moisture absorption: 0.2 percent by volume.

B. Insulation: ASTM C795; semi-rigid, noncombustible, end grain adhered to jacket.

1. ‘K’ value: ASTM C177, 0.24 at 75 degrees F.

2. Maximum service temperature: 650 degrees F.

3. Maximum moisture absorption: 0.2 percent by volume.

C. Vapor Barrier Jacket:
1. ASTM C921, White kraft paper with glass fiber yarn, bonded to aluminized film.

2. Moisture vapor transmission: ASTM E96; 0.02 perm-inches.

D. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

E. Indoor Vapor Barrier Finish:
   2. Vinyl emulsion type acrylic, compatible with insulation, white color.

F. Outdoor Vapor Barrier Mastic:
   1. Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

G. Outdoor Breather Mastic:
   1. Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

H. Insulating Cement:
   1. ASTM C449/C449M.

2.2 CELLULAR GLASS

A. Insulation: ASTM C552.
   1. ‘K’ value: 0.33 at 75 degrees F.
   2. Maximum service temperature: 900 degrees F.
   3. Maximum water vapor transmission: 0.1 perm.
   4. Maximum moisture absorption: ASTM C240, 0.2 percent by volume.

2.3 EXPANDED POLYSTYRENE

A. Insulation: ASTM C578; rigid closed cell.
   1. ‘K’ value: 0.23 at 75 degrees F.
   2. Maximum service temperature: 180 degrees F.
   3. Maximum water vapor transmission: 0.1 perm.
2.4 EXPANDED PERLITE

A. Insulation: ASTM C610; granular poured.
   1. ‘K’ value: 0.28 at 75 degrees F.
   2. Maximum service temperature: 1200 degrees F.
   3. Maximum water vapor transmission: 0.1 perm.

2.5 HYDROUS CALCIUM SILICATE

A. Insulation: ASTM C533 and ASTM C795; rigid molded, asbestos free, gold color.
   1. ‘K’ value: ASTM C177 and C518; 0.04 at 300 degrees F.
   2. Maximum service temperature: 1200 degrees F.
   3. Density: 1.5 lb/cu ft.

B. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

C. Insulating Cement:
   1. ASTM C449/C449M.

2.6 POLYURETHANE FOAM

A. Insulation: ASTM C591, rigid molded modified polyisocyanurate cellular plastic.
   1. ‘K’ value: ASTM 518; 0.14 at 75 degrees F.
   2. Minimum service temperature: -250 degrees F.
   3. Maximum service temperature: 250 degrees F.
   4. Maximum moisture absorption: ASTM D2842; 0.054 percent by volume.

2.7 POLYETHYLENE
A. Insulation: ASTM D1056 or D1667; flexible, closed cell, polyethylene, slit tubing.

1. ‘K’ value: ASTM C177; 0.25 at 75 degrees F.
2. Maximum service temperature: 200 degrees F.
4. Maximum moisture absorption: 1.0 percent by volume.
5. Moisture vapor transmission: ASTM E96; 0.05 perm-inches.
6. Connection: Contact adhesive.

2.8 CELLULAR FOAM

A. Insulation: ASTM C534; flexible, cellular elastomeric, molded or sheet.

1. ‘K’ value: ASTM C177; 0.27 at 75 degrees F.
2. Minimum service temperature: -40 degrees F.
3. Maximum service temperature: 220 degrees F.
4. Maximum moisture absorption: ASTM D1056; 3.5 percent (pipe) by volume, 6.0 percent (sheet) by volume.
5. Moisture vapor transmission: ASTM E96; 0.20 perm-inches.

B. Elastomeric Foam Adhesive:

1. Air dried, contact adhesive, compatible with insulation.

2.9 JACKETS

A. PVC Plastic.

1. Compatible with insulation.


1. Thickness: 0.020 inch sheet.
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2. Finish: Smooth.


4. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.

5. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verification of existing conditions before starting work.

B. Verify that piping has been tested before applying insulation materials.

C. Verify that surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION

A. Install in accordance with NAIMA National Insulation Standards.

B. Exposed Piping: Locate insulation and cover seams in least visible locations.

C. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, [pump bodies,] and expansion joints.

D. Glass fiber insulated pipes conveying fluids below ambient temperature:
   1. Provide vapor barrier jackets, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
   2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.

E. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.

F. For hot piping conveying fluids over 140 degrees F, insulate flanges and unions at equipment.
G. Glass fiber insulated pipes conveying fluids above ambient temperature:

1. Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples.

2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.

I. Inserts and Shields:

1. Application: Piping 1½ inches diameter or larger.

2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.

3. Insert location: Between support shield and piping and under the finish jacket.

4. Insert configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.

5. Insert material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.

J. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations.

K. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces: Finish with aluminum jacket.

L. Exterior Applications: Provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

M. Buried Piping: Provide factory fabricated assembly with inner all-purpose service jacket with self-sealing lap, and asphalt impregnated open mesh glass fabric, with one mil thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with a polyester film.

N. Heat Traced Piping: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

3.3 SCHEDULES
A. All small diameter (less than 8 inches in diameter) exterior exposed above grade piping transferring shall be aluminum jacketed with water resistant insulation and include heat tracing.

END OF SECTION
ELECTRICAL SPECIFICATIONS

16100 - BASIC MATERIALS AND METHODS FOR ELECTRICAL INSTALLATIONS

16200 - POWER GENERATION / UTILITY SERVICE

16300 - POWER DISTRIBUTION DEVICES

16301 – SHORT CIRCUIT STUDY

16302 – OVERCURRENT PROTECTION STUDY

16303 – ARC FLASH STUDY

16400 - POWER UTILIZATION DEVICES

16500 - INSTRUMENTATION DEVICES

16600 - CONTROL NARRATIVES

16700 – SCADA SYSTEM

Leslie P Shaw, PE
52576

Digitally signed by Leslie P Shaw,
PE 52576
Date: 2021.04.12
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PART 1 GENERAL

1.1 SUMMARY

A. It is the intent of the contract documents that upon completion of the electrical work, the entire system shall be in a finished workable condition. Therefore, furnish all work, labor, tools, superintendence, material, equipment, and accessories necessary to provide for a complete and workable electrical system as defined by the contract documents.

B. All work that may be called for in the specifications but not shown on the drawings, or all work that may be shown on the drawings but not called for in the specifications, shall be formed by the CONTRACTOR as if described in both. Should work be required which is not set forth in either document, but is nevertheless required for fulfilling the intent thereof, then the CONTRACTOR shall perform all such work as fully as if it were specifically set forth in the contract documents.

C. The drawings and specifications of other divisions of this contract, as well as supplements issued thereto, information to bidders, and other pertinent documents issued by the Owner's Representatives are a part of these drawings and specifications and shall be complied with in all respects. All the above documents will be on file at the office of the Owner's Representative and shall be examined by the CONTRACTOR. Failure to examine all documents shall not relieve the CONTRACTOR of any responsibility nor shall it be used as a basis for additional compensation due to omission of details of other divisions from the electrical documents.

D. The use of the word "furnish" or "install" or "provide" shall be taken to mean that the item or facility is to be both furnished and installed unless specifically stated to the contrary.

E. The use of the term "as (or where) indicated"; "as (or where) shown"; "as (or where) specified"; or "as (or where) scheduled" shall be taken to mean that the reference is made to the contract documents, either under the drawings or the specifications, or both documents.

F. The CONTRACTOR shall be responsible for visiting the site, checking the existing conditions, and shall determine the conditions to be met for installing the work and plan accordingly.

1.2 SYSTEM DESCRIPTION

Not used.

1.3 SUBMITTALS

A. The following is also applicable to Sections 16200, 16300, 16301, 16302, 16303, 16400, 16500, 16600 and 16700.
B. Each submittal shall be accompanied by a cover memo in which the contents of the submitted documents are described. This memo shall identify the project, whether the documents are “For Information”, “For Review and Approval” or “For Record”, and shall identify to which specification and section the attached documents are attempting to fulfill the submittal requirements thereof. Any documents submitted without the reference to which specification and section they are attempting to fulfill shall be rejected in whole without review.

C. Submit the following.

1. For Information:
   a. Elementary diagrams showing internal wiring of manufactured devices and assemblies.
   b. Point to point wiring diagrams showing terminations and wire numbers for each assembly.
   c. Dimension prints for each device or assembly
   d. Installation manual for each device or assembly
   e. Dimensions of areas required for servicing device or assembly
   f. Nameplate data and ratings for all devices
   g. Recommended spare parts and special tools list for maintaining equipment in service for one year and five year periods
   h. Recommended maintenance practices
   i. Catalog literature for each device or assembly

2. For Review and Approval:
   a. Review shall not remove responsibility for furnishing material or devices of acceptable dimensions, quantity, quality, or errors thereof.
   b. Drawings not clearly marked or lacking the contractor's approval stamp shall be rejected.
   c. Elementary (loop) diagrams showing schematically each device in a loop or control scheme, when not furnished with the ISSUED FOR CONSTRUCTION drawings.
   d. Panel layouts with bills of material.
   e. Specification and data sheets. Use manufacturer’s format for non-instrument devices and ISA format for instruments.
   f. Functional description of interlocks and control systems
   g. Sizing calculations for all flow measuring devices
h. Not used

i. PLC/SCADA interlock ladder-logic diagram or program listing

3. For Record:
   a. Operation and maintenance manuals shall be compiled six weeks prior to project completion for each device or assembly.
   b. Markup deviations to ISSUED FOR CONSTRUCTION drawings with red pencil and provide original to Engineer for record.

D. SAMPLES

1. Furnish samples when requested of materials and devices for acceptance review. When accepted, then that item of material or device installed shall be of equal or better quality than the sample. If quality of the installed material or device is not equal or better, then all such material or devices shall be replaced at the Contractor’s expense.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements

1. Secure all permits, licenses, and inspections as required by all authorities having jurisdiction. Give all notices and comply with all laws, ordinances, rules, regulations, and contract requirements bearing on the work.

2. Codes and ordinances having jurisdiction over the work shall serve as minimum requirements, but, if the contract documents indicate requirements which are in excess of those minimum requirements, then the requirements of the contract documents shall be followed. Should there be any conflicts between the contract documents and codes, or any ordinances having jurisdiction, then report these.

3. Determine the exact requirements for the utility services as set by the utilities that will serve the facility, and pay for and perform all work as required by those utilities. The Contractor shall notify the serving utility immediately upon award of the contract.

Effective 09/01/2004 all electrical work shall be performed by electricians and electrical contractors licensed in accordance with chapter 1305 of the Texas Occupations Code. All electrical work shall be performed by licensed electrical apprentices, licensed journeyman electricians, and licensed master electricians. Each electrical contractor shall be a licensed master electrician or employ a licensed master electrician. Each electrical contractor shall submit a copy of their master electrician’s license to the engineer prior to the start of electrical work.

1.5 SEQUENCING

A. Cooperate with all other trades to facilitate the general progress of the work. Allow other trades every reasonable opportunity for the installation of their work and the storage of their materials.
B. The work under this section shall follow the general building construction closely. Set all pipe sleeves, inserts, etc., and see that openings for cases, pipes, etc., are provided before concrete is placed or masonry installed.

C. Work with other trades in determining the exact locations of outlets, conduits, fixtures, and equipment to avoid interference with lines as required to maintain proper installation of other work.

D. Progress this work to not delay the work of other trades. Schedule the work so that completion dates as established by the Engineer are met. Furnish sufficient labor or work overtime to accomplish these requirements, if directed to do so.

1.6 COMMISSIONING

Test the insulation value of each service entrance cable, each feeder cable, and each branch circuit wire. Tests shall be made by means of a noncrank-type ohmmeter (megger) that impresses 500 volts dc across the insulation. Each ungrounded conductor shall have its insulation integrity tested after installation within its raceways from termination-to-termination. However, testing shall be made prior to connection to line or load. All such testing shall be done in the presence of the Owner’s Representative and the test results shall be submitted in writing to the engineer for review. The insulation value of each installed cable and wire shall be equal to, or greater than 50 Megohms. Should the insulation value be less than 50 Megohms for any conductor tested, the faulty conductor shall be replaced, and re-tested until compliance is achieved.

PART 2 PRODUCTS

2.1 MATERIALS

A. All materials and devices shall conform to the requirements of the contract documents. They shall be new and free from defects and shall conform to the requirements of the latest edition of NFPA 70, the National Electrical Code.

B. All materials and devices of the same class shall be supplied by the same manufacturer unless otherwise specified.

2.2 RACEWAYS – As called for in the plan set

A. Rigid metallic conduit shall be aluminum or hot-dipped galvanized steel, inside and out. Conduit couplings shall be aluminum or threaded steel with hot-dipped galvanized finish.

B. Concrete encased non-metallic conduit shall be thin wall PVC plastic type EB. Couplings shall be PVC solvent-weld type. Such conduit shall be Carlon or equal.

C. Plastic jacketed rigid metallic conduit shall meet the specifications for rigid conduit above and shall have a 40 mil minimum thickness PVC coating on exterior metallic surfaces and a minimum 2 mil urethane coating on interior metallic surfaces. Couplings shall be sleeved. Such conduit shall be Rob-Roy, Industry's "Red Hot", or equal.

D. Flexible liquid tight ferrous metallic conduit shall have an extruded thermoplastic cover with interlocked galvanized steel core. The conduit shall be U.L. listed. Such conduit shall be Anaconda, Republic, Electri-flex, or equal.

E. Seal fittings shall be malleable iron.
F. Rigid metallic conduit locknuts shall be galvanized steel in sizes under 2” and galvanized malleable iron on sizes 2½” and larger. Sealing locknuts shall have in addition to that specified above, an integrally fused thermoplastic gasket so that the locknut is rated NEMA-4.

G. Rigid metal conduit insulating bushings shall be molded canvas bake-a-lite type and suitable for operation in 100°C rise over 40°C ambient. Polypropylene bushings are not acceptable.

H. Grounding type bushings shall have threaded steel body, insulated throat, and ground lug. Insulated throat shall meet specifications under Article G above.

I. Rigid metallic conduit expansion/deflection fittings shall be watertight with a flexible plastic sleeve that allows ¾” movements in all directions. Hubs shall be threaded, galvanized malleable iron. Clamping bands shall be stainless steel. There shall be an equipment bonding ground jumper. Expansion deflection fittings shall be Crouse Hinds, OZ, or Engineer approved equal.

J. Rigid metallic conduit hubs shall be liquid-tight type with threaded female body, with sealing ring on conduit side and threaded male tapered steel body with hardened steel locknut on box side. Plastic jacketed hubs shall have 40 mils PVC coating. Such fittings shall be T&B, Crouse Hinds, or equal.

K. Chase nipples, reducers, enlargers, "Ericksons", capped els, short els, long els, split couplings and fittings shall be hot dipped galvanized malleable iron threaded type for use with rigid metallic conduit.

L. Rigid metal conduit bodies shall be cast aluminum with threaded hubs and gasketed cast metal covers with stainless steel screws. Conduit bodies shall be Crouse-Hinds Form 7 Condulets, Appleton Form 35 Unilets, or Engineer approved equal for non-hazardous and Division 02 locations. Listed explosion-proof fittings shall be used in Division 01 locations.

M. Liquid-tight flexible conduit fittings shall be hot-dipped galvanized steel body with captive grounding ferrule, sealing ring, and compression nut. Connector body shall have nylon-insulated throat. Pullout resistance of each completed connector shall be at least 1½ times U.L. minimum. Such fittings shall be T&B Crouse-Hinds, Appleton, or equal.

N. Rigid metal conduit boxes shall be cast aluminum with threaded integrally-cast hubs, cast metal cover, and with stainless steel cover screws. Such boxes shall be Crouse-Hinds "Condulets", Appleton "Unilets", or equal. Plastic jacketed type shall have 40 mils minimum coating of PVC.

O. Cadmium plated devices and hardware shall not be acceptable.

P. Any and all conduits penetrating fire rated walls shall do so only through UL listed openings having a fire rating equal to or greater than the fire rating of the wall which they penetrate. All such openings shall be installed in accordance with the manufacturer’s instructions.

Q. No conduit shall be embedded or concealed in a fire rated wall.

2.3 MANHOLES – Not used
2.4 WIRING

A. 600 Volt Building Wire:

1. All conductors for power and control wiring shall be stranded, soft drawn copper.

2. Insulation for Power and Control Circuitry shall be THHN/THWN, 600 volt rated, 75 C rated.

3. All connectors shall be rated for 75 C.

4. The ampacity of all conductors and connectors shall be on the basis of a 75 C rating

5. Factory pigmented insulation color for sizes #6 and smaller for building power wiring shall be as follows:
   a. 150V-to ground, or less: phase A - Red, phase B - Black, phase C - Blue.

   Grounding Conductor - Green
   Grounded Conductor - White


   Grounding Conductor - Green
   Grounded Conductor - Grey

6. Bare conductors for grounding purposes shall be hard-drawn stranded copper.

B. Instrumentation and SCADA Hook-up Wire

1. Instrumentation hook-up wire shall be 600V. U.L. rated #16 AWG tinned copper stranded (19x29) with 32 mil polyethylene insulated, twisted pair or triad with aluminum-polyester shield and #18 AWG stranded tinned copper drain wire and a 32 mil chrome vinyl jacket. The wire shall be Belden 8719 for 2/C and Belden 8618 for 3/C or equal by Dekeron. Other types shall be as noted on the Contract Drawings.

C. Connectors

1. Mechanical connectors shall be bolted pressure type with tin-plated bronze body and tin-plated silicon-bronze hardware.

2. Insulated setscrew connectors shall consist of copper body with flame-retardant, 600V class insulated shell. Such connectors shall be Ideal, T & B, 3M, or equal.

3. Terminal connectors for flat-head terminal screws shall be locking spade type with vinyl insulated compression indent shaft, T&B, Ideal, Amp, or equal.
4. Terminal strips shall be channel-mounted types with tin-plated solderless box lugs contained with barriered nylon-insulated separable barriers. Such devices shall be Square D, Cutler-Hammer, Allen Bradley, or equal.

D. Insulating Products

1. General purpose electrical tape shall be 7 mil thick stretchable vinyl plastic, pressure-adhesive type; Plymouth "Slipknot Grey", 3M "Scotch #33, or equal.

2. Insulation putty shall be rubber-based, non-vulcanizing, elastic-type putty in tape form; Plymouth #2074, 3M "Scotchfill", or equal.

3. High Temperature, insulating void filling, moisture-proof tape shall be stretchable ethylene propylene rubber with high-tack, self-fusing surfaces. Tape shall be rated for 90°C continuous, 130°C overload. Such tape shall be Plymouth "Plysafe", 3M Scotch 23", or equal.

4. High temperature protective tape shall be rated 180°C continuous, Indoor/outdoor and shall be cured, self-fusing silicone rubber. Such tape shall be Plymouth "Plysil", 3M "Scotch 70", or equal.

5. Arc and fireproofing tape shall be oil and water resistant, heat resistant, fabric reinforced; Plymouth "Plyarc #3318", 3M "Scotch 7700", or equal.

E. Labels, Nameplates, and Signs

1. Marking labels for wire numbering shall be typed-on heatshrink plastic. Such labels shall be Raychem "Shrinkmark", or equal.

2. Write-on type labels for identification of conduits shall be weather resistant polyester with flat surface for marking pen application.

3. Colored bonding tape shall be 5 mil stretchable vinyl, self-adhesive (with permanent solid colors corresponding to hereinbefore specified wire colors) Plymouth "Slipknot 45", 3M "Scotch 35", or equal.

4. Micarta nameplates shall be 3/32" inch thick, lengths as required to accommodate lettering, and in ¾" and 1¼" widths. Each plate shall have adhesive backing with pull-apart resistance of at least 100 psi. Plates shall be laminated type with black background and white letters. Nameplates shall be installed on all starters, switches, relays, contactors, etc.

5. Signs shall be similar to nameplates in (4) above with the size, type, and wording as indicated on the contract drawings.

6. DETECTABLE WARNING TAPE Plastic, detectable tape shall be polyethylene film with a metalized foil core and shall be 4-6 inches (75-150 MM) wide. Tape shall be red with black letters marked ‘WARNING ELECTRICAL’. 
F. Supporting Devices

1. Slotted channel supports and framing members shall be cold rolled steel. Finish for inside, dry location in finished areas (such as offices) shall be factory painted with baked-on enamel. Finish for outside and damp or wet locations shall be hot dipped galvanized after fabrication. Size of slotted channels unless otherwise indicated, shall be 1\(\frac{5}{8}\)" x 1\(\frac{5}{8}\)" in cross-section. Furnish Unistrut P-1000, Elcen Figure 600, or equal. Special purpose slotted channel support shall be furnished as indicated.

2. Hanger rods shall be hot dipped-galvanized and shall be all-thread type, 3/8" minimum diameter.

3. Beam clamps, side-beam connectors, and one-hole clamps shall be hot-dipped galvanized malleable iron, and shall be Steel City, T&B, or Gedney. Plastic coated types shall have 40 mils, minimum PVC covering.

4. Pressed steel, two-piece single bolt, slotted channel conduit straps shall be electro-galvanized and shall be of the same manufacturer as the slotted channel. Plastic coated types shall have 40 mils, minimum PVC covering and hardware shall be stainless steel.

5. Single rod-hung "J" conduit clamps shall be adjustable type with hot dipped galvanized finish and shall be Unistrut J-1200 series, Elcen figure 90, or equal.

6. Indoor, dry-location slotted channel hardware (nuts, bolts, washers, etc.) shall have electro-galvanized finish. Outdoor, wet location slotted channel hardware shall be stainless steel.

7. Stainless steel hardware shall be AISI Type 304 or 316.

8. Plywood shall be solid-core, marine type suitable for wet locations. Edge trim shall be oak. Trim glue shall be epoxy type waterproofed glue.

9. Concrete and masonry anchors shall be stainless steel type equal to Hilti brand.

G. GROUNDING DEVICES

1. Ground rods shall be copper clad steel in 30 foot lengths, unless otherwise specified.

2. Ground rod connectors shall be copper alloy with silicon bronze bolts and in sizes to fit ground rod diameters. Furnish OZ, Burndy, or equal.

3. Pipe ground connectors shall be copper alloy with silicon bronze bolts and in sizes to fit pipe diameter. Furnish OZ, Burndy, or equal.

4. Thermal welding devices shall consist of correct size molds to fit application and correct amount of weld metal. Furnish Enrico "Cadweld", Burndy "Thermoweld", or equal.
PART 3 EXECUTION

3.1 EXAMINATION

A. Except where specifically detailed or shown, the locations and elevations of equipment are approximate and are subject to small revisions as may prove necessary, or desirable, at the time the work is installed. Final locations shall be confirmed with the Engineer in advance of construction. Confirmed locations shall be made for the following: poles, receptacles, rough-ins and connections for equipment furnished under other sections, lighting fixtures, outlets, motor control centers, switchboards, panelboards, etc.

B. Where equipment is being furnished under another section, request from the Engineer an accepted drawing that will show exact dimensions of required locations of connections. Install the required facilities to the exact requirements of the approved drawings.

C. The drawings are diagrammatic and do not give exact details as to elevations or routings of conduits, nor do they show all offsets and fittings; nevertheless, install the conduit system to conform to the structural and mechanical conditions of the construction. Unless locations and routing of exposed conduits are dimensioned, confirm locations and routing prior to installation with the Engineer.

3.2 INSTALLATION

A. All work shall be done in the best and most workmanlike manner by qualified, careful electricians who are skilled in their trade. The electrical contractor shall employ a Texas licensed master electrician assigned to this project and all electricians serving this project shall be Texas licensed electricians. The standard of work required throughout shall be of the first class only and electricians whose work is unsatisfactory to the Engineer shall be dismissed from the work upon written notice from the Engineer. All work must meet the approval of the Engineer.

B. Cabling inside equipment shall be carefully routed, trained, and laced. Cables so placed that they obstruct equipment devices shall not be accepted.

C. Equipment shall be set level and plumb. Supporting devices installed shall be set and braced so that equipment is held in a rigid, tight-fitting manner.

3.3 DUCTBANK / MANHOLE

A. Ductbank

1. Install duct to locate top of ductbank at depths as indicated on drawings.

2. Install duct with minimum slope of 4 inches per 100 feet (0.33 percent). Slope duct away from building entrances.

3. Cut duct square using saw or pipe cutter; de-burr cut ends.

4. Insert duct to shoulder of fittings; fasten securely.

5. Join nonmetallic duct using adhesive as recommended by manufacturer.
6. Wipe nonmetallic duct dry and clean before joining. Apply full even coat of adhesive to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum.

7. Install no more than equivalent of three 90-degree bends between pull points.

8. Provide suitable fittings to accommodate expansion and deflection where required.

9. Not used

10. Not used

11. Not used

12. Not used

13. Not used

14. Not used

15. Not used

16. Provide suitable pull string in each empty duct except sleeves and nipples.

17. Swab duct. Use suitable caps to protect installed duct against entrance of dirt and moisture.

18. Backfill trenches.

B. Manhole – Not used

3.4 RACEWAYS

A. Install the conduit system to provide the facility with the utmost degree of reliability and maintenance free operation. Kinked conduit, conduit inadequately supported or carelessly installed shall not be accepted.

B. Raceways shall be installed for all wiring runs except as otherwise indicated.

C. Conduit sizes, where not indicated, shall be code-sized to accommodate the number and diameter of wires to be pulled into the conduit. Use NEC tables for sizing.

D. Exposed runs of conduit shall be installed parallel to the lines of the structure.

E. PVC runs shall be joined with manufacturer's approved cement.

F. Finished installation of conduit runs from each terminus to each terminus shall be watertight.
G. Generally, raceways shall be installed exposed on the structures and in the buildings except as otherwise specified. Horizontal runs shall be supported on 24" centers and vertical runs on 48" centers.

H. Conduit runs in finished areas within building shall be installed concealed within the structure but not in the slab, except as otherwise specified.

I. Except where up-turns to structures and equipment is made. The up-turn shall be made with 40 mil PVC coated steel 90° elbow and conduit. Depth of lateral runs shall be 24" minimum unless otherwise indicated. Coordinate installation with site work finished grades. Duct bank depths shall be as indicated on the drawings.

J. Conduit runs that enter an enclosure without penetrating the sheet metal, such as bottom entry into motor control centers, shall be equipped with bushings.

K. Conduit bodies such as "LB, "T", Condulets, Unilets, or equal shall be installed in exposed runs of conduit wherever required to overcome obstructions, and to provide pulling access to wiring. Covers for such fittings shall be accessible and unobstructed by the adjacent construction.

L. Conduit shall enter all wireways, boxes, motor control centers, panelboards and other enclosures straight and true. Conduits installed cocked and not parallel to the lines of the enclosure shall not be acceptable.

M. Conduit entrances into equipment shall be carefully planned. Cutting away of enclosure structure, torching out braces, and removal of enclosure channels and sills shall not be accepted.

N. Use approved hole cutting tool for entrances into sheet metal enclosures. Use of cutting torch or incorrect tool shall not be accepted.

O. Install expansion or expansion/deflection fittings where conduit runs across an expansion joint within the concrete, or where conduit runs across an expansion joint and the runs are rigidly attached to the structure.

P. Plastic jacketed flexible metallic conduit shall be used for connections to motors, solenoids, pressure switches, electric valve operators, unit heaters, motorized louvers, torque switch devices, flowmeters, limit switches, lay-in lighting fixtures, and other devices that may need to be removed for servicing in non-hazardous locations.

Q. Flex runs shall be joined with specified flex connectors and these connectors shall be made up tightly onto the lengths of flex and onto its connected devices. All plastic jacketed flexible conduit connections shall be watertight.

R. Cap each end of conduits as soon as placed to prevent mud, dirt, debris, and water from entering raceways. Each run shall be swabbed clean prior to wire pulling.

S. All junction and pull boxes shall be equipped with blank covers.

T. All boxes shall be installed with their axes parallel to the lines of the building structure.

U. All conductors shall be the size as indicated and where no size is given, the conductor size shall be #12 AWG, unless otherwise specified.
V. Generally, control wiring shall be #14 AWG.

W. All wiring shall be installed in raceways unless otherwise indicated.

X. All power and control wiring shall be made with insulated, stranded copper wire.

Y. No wire or cable shall be drawn into a conduit until all work of a nature which may cause injury is completed. A cable pulling compound shall be used as a lubricant and its composition shall not affect the conductor or its insulation.

Z. Do not exceed cable manufacturer’s recommended pulling tensions.

AA. Service and feeder wiring runs shall be made from terminus to terminus without splice.

BB. Branch circuits shall run from supply to load without splice except where taps and splices are required for receptacle, light fixture, and small appliance loads.

CC. Taps, splices, and connections shall be made with tinned copper alloy compression connectors. Make up connection tightly to produce as low a resistance as if the conductor were continuous. Such connectors shall be insulated with a smooth cover of void-filling insulation putty and then covered with at least four (4) half lapped layers of electrical tape. Insulated connector shall have at least 1½ KV insulation value.

DD. Specified sizes of wire shall be installed with factory-pigmented colors. Phase label black pigmented wires with colored banding tape as specified. Install labels at each terminus.

EE. Numbered marking labels shall be installed to identify circuit numbers from panelboards and to identify control wires. Install labels on each wire in each panelboard, junction and pullbox, and device and control connection.

FF. Label each wiring run with write-on waterproof labels inside each motor control center, switchboard, pullbox and handhole. Wrap label ties around wire group at conduit entrance and write on label the wire size, conduit size, and service.

GG. Control wiring that terminates onto flat head type terminals shall be equipped with crimp-type spade lugs. Label each wire with number to correspond with terminal strip number.

HH. All wiring inside enclosures shall be neatly trained and laced with tie-wraps.

II. All raceway systems, outlets, boxes, wireways, cabinets, enclosures, lighting fixtures, transformers, and related equipment shall be adequately and safely supported with at least 3-1 safety factor.

JJ. Slotted channels shall be used to support equipment that is mounted free of structure. Use factory fabricated back-to-back hot-dipped galvanized members 3¼" deep that have welded feet.

KK. Runs of exposed conduits shall be installed as follows:
LL. Single surface runs shall be attached to the structure by means of conduit clamps, except as otherwise specified. Single runs along structural members shall be supported by means of side beam clamps, or similar supporting devices.

MM. Multiple surface runs shall be attached to the structure by means of slotted channels. Each conduit shall be attached to the slotted channel by means of two-piece conduit clamps.

NN. Rod hangers shall be hot dipped, galvanized all thread, 3⁄8” minimum diameter steel type. Paint each rod hanger and its support with undercoat and one finish coat of galvanized type paint.

OO. Rod hangers shall be attached to the structure with appropriate hanger such as concrete insert, beam clamp, ceiling flange, or side beam connector.

PP. Slotted channels that are field cut shall have raw edges painted with cold galvanized coating spray paint.

QQ. Plywood that is used to mount equipment shall be marine grade and shall be painted with prime and two (2) finish coats of epoxy paint.

3.5 EXCAVATION AND BACKFILLING

A. Complete excavating and back-filling necessary for the installation of the work. This includes shoring and pumping in ditches to keep them dry until the work has been installed. Shoring required to protect the excavation and safeguard employees shall be properly performed. See TRENCH SAFETY SYSTEM section of the specifications.

B. All excavations shall be made to the proper depth, with allowances made for floor slabs, forms, beams, finished grades, etc. Soil under conduits shall be well compacted before conduits are installed.

C. All backfill shall be made with selected soil, free of rocks and debris and shall be pneumatically tamped in six-inch layers to secure a field density ration of 90 percent, unless otherwise specified.

D. All excavated material not suitable and not used in the backfill shall be removed to the on-site disposal area. The disposal area shall be as directed by the Engineer.

3.6 CUTTING AND PATCHING

A. Cutting and patching required under this section shall be done in a neat workmanlike manner. Cutting lines shall be uniform and smooth.

B. Use concrete saws for large cuts in concrete and use core drills for small round cuts in concrete.

C. Where large openings are cut through metal surfaces, attach metal angles around the opening.

D. Patch concrete openings that are to be filled with nonmetallic, non-shrinking grout. Finished concrete patching shall be troweled smooth and shall be uniform with surrounding surfaces.

E. No cutting of structural elements shall be done without permission of the Engineer.
F. Where openings are cut through masonry walls, provide lintel or other structural supports to protect the remaining masonry. Adequate support shall be provided during the cutting operation to prevent damage to the masonry.

G. Holes for raceway penetration into sheet metal cabinets and boxes shall be accurately made with a hole-punch. Cutting openings with a torch or other device that produces a jagged, rough-cut shall not be accepted.

H. Raceway entry into equipment shall be carefully planned. Cutting of enclosure framework to accommodate poorly planned raceway placement shall not be accepted.

3.7 FLASHING

A. Provide waterproof flashing for each penetration of exterior walls and roofs.

B. Flashing for conduit penetrations through built-up roofs shall be made with pitch panel filled full with pitch.

3.8 REPAIR/RESTORATION

A. Field check and verify the locations of all underground utilities prior to any excavation. Avoid disturbing these as far as possible. In the event existing utilities are broken into or damaged, they shall be repaired so as to make their operation equal to that before the excavation was started.

B. Where the excavation requires the opening of existing walks, drives, or other existing pavement, these facilities shall be cut as required to install new lines and to make connections to existing lines. The sizes of the cuts shall be held to a minimum, consistent with the work to be installed. After installation of new work is completed and the excavation has been backfilled in accordance with the above, then repair existing walks, drives, or other existing pavement to match existing installation.

3.9 CLEANING

A. Remove all temporary labels, dirt, paint, grease, and stains from all exposed equipment. Upon completion of work, clean equipment and the entire installation to present a first class job suitable for occupancy. No loose parts or scraps of equipment shall be left on the premises.

B. Equipment paint scars shall be repaired with paint kits supplied by the equipment manufacturer, or with an approved paint.

C. Clean interiors of each item of electrical equipment. At completion of work, all equipment interiors shall be free from dust, dirt, and debris.

3.10 PROTECTION

A. Provide suitable protection for all equipment, work, and property against damage during construction.

B. Assume full responsibility for material and equipment stored at the site and incorporated within the project.
C. Conduit openings shall be closed with caps or plugs during installation. All outlet boxes and cabinets shall be kept free of concrete, plaster, dirt, and debris.

D. Equipment shall be covered and tightly sealed against entrance of dust, dirt, and moisture.

E. Prior to energization, all dry type transformers shall be protected against moisture and dirt absorption by a suitable covering. Maintain heat inside the covering by means of incandescent lamps (200-watt minimum.)

F. Interiors of switch gear and motor control centers shall be kept clean and dry prior to energization. Maintain heat inside each unit with one 200-watt lamp located at the bottom of each vertical section. Energizing integral condensation heaters shall be acceptable alternate.

END OF SECTION
POWER GENERATION - PART 1 GENERAL

1.1 SUMMARY

The Dundee State Fish Hatchery is served by Southwest Rural Electric Cooperative by multiple meters. One existing service, which powers the spawn building, has an existing standby electrical generator, which is controlled by an existing ATS (automatic transfer switch). No modification to the existing standby generator is to be provided by this project.

A standby generator service complying with NFPA 110. Type 60, Class 48, Level 2 and the provisions for a legally required standby power system shall be provided for the ozone facility. The new generator will interface with a new power distribution system and a new utility service for the ozone facility. This specification includes the engine/generator, generator overcurrent protection, transfer switch, enclosure and associated controls and accessories.

The ATS shall be a base bid item. The generator is an add alternate item.

1.2 REFERENCES

A. NFPA 70 (National Electrical Code) Section 701 – Legally Required Standby Systems.


1.3 SYSTEM DESCRIPTION

A. Fuel: Fuel: 48 hours of diesel at generator rated capacity

B. Engine/Electrical Ratings: 480 vac wye, solid grounded neutral, voltage dip not to exceed 15% when the following loads are applied. Running kva at .8 pf lagging. Starting kva loads are induction motors. The generator (engine) shall be 12-lead, rated at least 250-kw (alternator rated not less than 350-kw) at the specified service conditions and at engine speeds not to exceed 1800 rpm.

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
<th>Load</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lights, heat controls</td>
<td>15-kva</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>O3 Destruct</td>
<td>5-hp</td>
<td>FVNR</td>
</tr>
<tr>
<td>3</td>
<td>Cooling system</td>
<td>30-hp</td>
<td>FVNR</td>
</tr>
<tr>
<td>4</td>
<td>PSA O2 Gen</td>
<td>.36-kw</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Air Compressor</td>
<td>30-hp</td>
<td>FVNR</td>
</tr>
<tr>
<td>5</td>
<td>Injection pumps</td>
<td>2 each 25-hp</td>
<td>FVNR</td>
</tr>
<tr>
<td>6</td>
<td>O3 Generator</td>
<td>39-kw</td>
<td>Non-linear</td>
</tr>
<tr>
<td>6</td>
<td>Dryer</td>
<td>7.5-hp</td>
<td>FVNR</td>
</tr>
</tbody>
</table>
C. Environmental Ratings: Outdoor (NEMA 3R enclosure), -20°F to +110°F, 500 ft above mean sea level, residential rated muffler and sound controlled enclosure that limits noise to not more than 76 dBA when measured at 23 feet in any direction from the enclosure. Equipment shall be rated to produce specified horsepower under these conditions and within this enclosure. Each system shall be certified to meet EPA Standby / Emergency TIER requirements in effect at time of startup. The enclosure shall be designed, constructed, tested and certified to withstand sustained winds of 90 mph and gusts of 110 mph.

D. This generator shall be part of a coordinated package that includes the generator, generator overcurrent protection, automatic transfer switch, controller, enclosure and associated accessories.

1.4 SUBMITTALS

A. SHOP DRAWINGS

Provide electrical characteristics and connection requirements. Provide plan and elevation views with overall and interconnection point dimensions, fuel consumption rate curves at various loads, ventilation and combustion air requirements, electrical diagrams including schematic and interconnection diagrams.

B. PRODUCT DATA

Provide data showing dimensions, weights, ratings, interconnection points, and internal wiring diagrams for engine, generator, control panel, battery, battery rack, battery charger, exhaust silencer, vibration isolators, tank, and radiator.

C. CERTIFIED PROTOTYPE TEST REPORTS

Provide test results for: maximum power (kw), maximum starting kva at 15% voltage drop, governor speed regulation under steady state and transient conditions, voltage regulation and generator transient response, harmonic analysis, telephone influence factor, ground fault short circuit, and three phase short circuit.

D. CLOSEOUT SUBMITTALS

Provide installation, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. QUALIFICATIONS

The generator system shall be furnished by a single manufacturer who shall be responsible for the design, coordination, and testing of the complete system. The entire system shall be installed as shown on the plans, drawings, and specifications. The equipment shall be produced by a manufacturer who has produced this type of equipment for a period of at least 10 years and who maintains a service organization available twenty-four hours a day throughout the year.

All generator systems shall meet all regulatory requirements in effect at time of startup. Contractor shall submit with bid a letter stating that they understand the
regulatory requirements for engine driven standby generators to be operated at this location and that their bid is based on equipment that is certified to meet these regulatory requirements. The contractor shall provide a written certification to the owner prior to placing the generator into service that the standby power system installed meets all regulatory requirements in effect at time of commissioning. No standby power system shall be accepted for use without said written certification on file with the owner.

B. SEQUENCING

The loads powered from the existing generator service shall be abandoned or integrated into the new generator service before the existing generator service is removed.

C. WARRANTY

A five-year / 3000-hour parts and labor at site warranty for all non-consumable devices shall be provided.

D. SYSTEM STARTUP / COMMISSIONING

System startup shall not begin until the Engineer has performed a site evaluation and all punch list items resulting from that evaluation have been completed to the satisfaction of the Engineer.

The generator shall be started up by the manufacturer's authorized personnel and in accordance with manufacturer's requirements. The generator system shall be checked-out, commissioned, and tested in accordance with the manufacturer's instruction manual and in accordance with the acceptance testing requirements of NFPA 110 Section 7-13. This includes on-site full load testing. The manufacturer's representative shall perform these checks and tests being witnessed by the owner (or his representatives) and shall provide certified check and test reports. The fuel tank shall be filled by the contractor at the conclusion of startup and commissioning.

E. MAINTENANCE

Extra Materials: Provide one set of specialized tools required for preventative maintenance of the engine / generator system. Provide two each fuel, oil, and air filters.

PART 2 MATERIALS

2.1 MANUFACTURERS

A. Acceptable manufacturers of generator engines are: Cummins, Perkins, John Deere, Caterpillar, Iveco, Generac, Mercedes-Benz and Detroit.

B. Acceptable manufacturers of complete generator assemblies are: Blue Star, Caterpillar, Cummins, Generac, Kohler and Rolls Royce MTU America.

C. Acceptable manufacturers of automatic and/or non-automatic transfer switches are: ASCO, Cummins, Eaton and Generac.
D. Acceptable manufacturers of generator main circuit breakers are: ABB, Eaton, General Electric, Schneider/Square D and Siemens.

2.2 ENGINE/GENERATOR/CONTROLLER/CIRCUIT BREAKER

A. Diesel engine driven

B. Type 60 – The maximum time that the Standby Power Supply System (SPSS) allows the transfer switch to be without acceptable electrical power shall be 60 seconds.

C. Class 48 – The minimum time for which the SPSS is designed to operate without being refueled shall be 48 hours.

D. Level 2 – The level of performance shall meet level 2 requirements as defined in NFPA 110.

E. Provide an automatically controlled heater to keep the jacket water temperature at not less than 90°F.

F. The governor shall control the frequency to 60 Hz +/- 2 Hz at all conditions of loading specified.

G. The starting devices shall: be battery operated; provide cycle cranking; provide three crank cycles of 75 seconds; provide a continuous crank cycle of 45 seconds; provide a float-type battery charger having a dc ammeter, dc voltmeter, 36 hour maximum recharge time, and low battery voltage alarm contacts.

H. The batteries shall be of the lead-acid type.

I. The control panel shall be specifically approved (UL listed) for a Level 2 SPSS.

J. Provide an emergency stop station external to the unit’s weather-proof housing.

K. Provide the following indicators, alarms, and automatic shutdowns:

<table>
<thead>
<tr>
<th>Function</th>
<th>Control Panel Visual Indicator</th>
<th>Shutdown</th>
<th>Switch contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Over crank</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Low jacket temp.</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High engine temp.</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Low lube oil press.</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Low coolant level</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lamp test</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Common alarm</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Air shutdown damper</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Remote emerg. Stop</td>
<td></td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

L. The cooling system shall be a forced air / liquid cooled unit mounted radiator.

M. The exciter shall be of the rotating type.
N. The enclosure shall be provided with a battery powered emergency lighting system.

O. A UL listed sub-base secondary containment fuel tank shall be provided.

P. The generator shall provide and sustain 300% of rated current for 10 seconds during three phase and ground fault conditions.

Q. Provide Class F insulation.

R. A three phase 600 amp frame circuit breaker with 600 amp trip unit having instantaneous phase overcurrent, time delay phase overcurrent, and instantaneous ground sensor overcurrent relaying shall be provided. This breaker shall also be equipped with shunt trip and auxiliary contacts. This breaker shall be mounted inside the weather protected housing of the engine/generator set in its own NEMA 1 enclosure.

S. The controller shall be mounted in a NEMA 1 enclosure inside the weather protected housing of the engine/generator set. The controller shall be equipped to accept a device capable of allowing maintenance personnel to test the controller performance without operating the engine.

T. The alternator shall be provided with an anti-condensate heater powered from the engine block heater circuit and shall not exceed 1500-wattts.

U. The generator shall be provided with a fuel level transmitter, 4-20 mA.

V. The generator enclosure shall be provided with a limit switch on each door. Each switch shall be wired in series such that if any door is not fully closed, then an open contact condition shall occur, which can be monitored remotely.

2.3 AUTOMATIC TRANSFER SWITCH

A. Performance shall meet Type 60 and Level 2 requirements as defined in NFPA 110 and UL listed as such.

B. The transfer switch shall be rated for 600 volts, 600 amps continuous, 600 amps close, 600 amps interrupting, and braced for 30k amps asymmetrical.

C. The transfer switch shall be housed in a NEMA 3R rack mounted enclosure.

D. Mechanical interlocking shall be provided to prevent interconnection of the primary power supply and the generator power.

E. The transfer switch shall be four-pole with ground bus and without bypass – isolations switches.

F. Transfer from generator power to normal power shall be synchronous, automatic, and open transition. Out of phase or out of frequency transfer shall not be permitted. Transfer from normal to generator power during testing shall also be synchronous, automatic, and open transition.

G. An automatic exerciser shall be provided.
PART 3 EXECUTION

3.1 INSTALLATION

Install in accordance with manufacturer’s instructions.

3.2 DEMONSTRATION

Simulate power outage by interrupting normal source and demonstrate that the system operates to provide standby power.

3.3 TRAINING

Manufacturer’s certified personnel shall provide eight hours of on-site operator training for each standby power system. Training shall cover maintenance, operation, and trouble-shooting of the devices provided. Training shall begin only after startup and commissioning have been completed.

UTILITY SERVICE - PART 1 GENERAL

1.1 SUMMARY

A new utility service to a new distribution system at a new facility shall be provided.

1.2 SYSTEM DESCRIPTION

The utility shall extend the overhead supply to a location specified on the drawings and provide a 240/480-vac, 3-phase, 4-wire, solidly grounded center tapped delta, 400-amp service. \( V_{ab} = V_{bc} = V_{ca} = 480\text{vac}, V_{bn} = V_{cn} = 240\text{vac} \) & \( V_{an} = 416\text{vac} \).

1.3 SEQUENCING – Not used

PART 2 MATERIALS – Not used

PART 3 EXECUTION

3.1 The contractor shall: notify the serving utility immediately upon award of the contract, determine the exact requirements for the utility services as set by the utilities that will serve the facility and perform all work required by those utilities. The owner shall pay all fees and provide all easements to the utility company (SWRE) for the extension of utility lines to the ozone facility.

END OF SECTION
SECTION 16300

POWER DISTRIBUTION DEVICES

PART 1 GENERAL

ARC FLASH – SHOCK PROTECTION

1. All equipment shall be labeled in accordance with NFPA 70 Article 110.16 (latest edition) to warn qualified personnel of potential electric arc flash hazards.
2. All flash hazard reduction and shock protection features available as factory options for power distribution devices shall be provided. Such features may include, but are not limited to thermography windows, view ports and finger safe voltage test points.
3. Provide UL 1436 listed absence of voltage testers where called for in the single line diagram.

PART 2 MATERIALS

2.1 Wiring Devices – as called for in the plan set

A. All wiring devices shall be specification grade, Arrow-Hart, Hubbell, or equal.
B. Two-pole, 3-wire grounding 15A/125V, NEMA 5-15R duplex receptacle shall be AH #5262, Hubbell #5262, or equal.
C. Two-pole, 3-wire grounding 20A/125V, NEMA 5-20R duplex receptacle shall be AH #5362, Hubbell #5362, or equal.
D. Two-pole, 3-wire grounding 20A/250V, NEMA 6-20R single receptacle shall be AH #5462, Hubbell #5461, or equal.
E. Two-pole, 3-wire grounding 30A/250V, NEMA 6-30R single receptacle shall be AH #5700, Hubbell #9330, or equal.
F. GFCI device shall be a duplex 5-15R, 15 amp, 125 V, 3-wire outlet with reset and test pushbuttons AH Catalog #GF5242, Bryant GFR52FT, or equal. Dry location enclosure shall consist of coverplate AH Catalog #901061, Bryant Catalog #T1-S, or equal on a stamped steel box. Wet location enclosure shall consist of coverplate AH Catalog #4501-FS on cast metal FS box.
G. Single-pole, single-throw, 20A toggle switch shall be AH #1991, Hubbell #1221, or equal.
H. Single-pole, double-throw (three-way) 20A Toggle switch shall be AH #1993, Hubbell #1223, or equal.
I. Double-pole, double throw 20A toggle switch shall be AH #1994, Hubbell #1224, or equal.
J. Manual motor controller shall be Allen Bradley Bulletin 600, Square D Class 2510, or equal, Select overloads to be 1.15 times motor FLA.
K. Covers for wiring devices located out-of-doors in damp or wet locations shall have weatherproof cover, gaskets, and stainless steel cover screws.
L. Covers for surface wiring devices located indoors and in dry locations shall be stainless steel type with beveled edges.

2.2. MOTOR CONTROL CENTERS – Not used

2.3. Separately Mounted Controllers – Not used

2.4. Disconnecting Means – Safety Switches
   A. Where disconnecting means are required by the NEC or project documents, disconnecting means shall be identified (marked labelled) as required by the NEC. Disconnecting means shall be load break rated, unfused, switches opening all ungrounded conductors powering the equipment for which they are intended to disconnect. Switch enclosures shall have viewing window(s) and highly visible means for the switch operator to identify that all blades of the switch are open. Switches shall be provided with the means to pad lock in the open position and when pad locked in the open position shall not be able to be closed. All disconnecting means shall be suitable for lock-out tag-out service.
   B. Safety switches shall be size and type as indicated on the single line diagram. Each disconnect means shall be heavy-duty (unless specifically denoted otherwise), quick-make, quick-break mechanisms.
   C. Unless otherwise indicated, safety switches shall be in a NEMA 4X, aluminum enclosure.

2.5. Fuses
   A. Fuses shall be furnished for each fused overcurrent device and, in addition, three spare fuses for each rating required shall be furnished.
   B. Fuses above 600 ampere shall be constructed using silver links with a fusing alloy soldered to the link for low temperature overload protection. The design shall provide time-delay of not less than 45 seconds at 300 percent of ampere rating. The interrupting rating shall be at least 200,000 amperes RMS symmetrical.
   C. Fuses rated 600 amperes or less shall be dual element Class R, time-delay type. Such fuses shall incorporate separate thermal overload and short circuit elements. The design shall provide time delay of not less than ten seconds at 500 percent of ampere rating. The interrupting rating shall be 200,000 amperes RMS symmetrical.
   D. Fuses shall be Bussman, Chase-Shawmut, or equal.

2.6. Dry Type Transformers
   A. All general purpose dry-type transformers shall be not greater than 150°C rise over 40°C ambient and shall have KVA ratings and voltage as indicated.
   B. Core and coils shall be housed in a ventilated NEMA rated enclosure appropriate for the location.
   C. Core and coils shall be equipped with NEMA standard full capacity taps in the high voltage windings.
   D. Short-time overload capability shall be in accordance with ANSI C57.12.
E. Noise levels guaranteed for each transformer shall be no more than the following when measured by ANSI C89.1: 50 KVA and below - 45 db and 51 KVA and through 300 KVA - 50 db

F. Dry type transformers shall be Sorgel, GE, or equal.

### 2.7 Panelboards

A. Panelboards shall be dead-front type and shall be manufactured in accordance with Underwriters’ Laboratories, Inc., standard for Panelboards (UL67).

B. The panelboards shall include automatic short circuit and over-current protective devices of the molded case circuit breaker type. All multi-pole breakers shall be so designed that an overload on one pole automatically causes all poles of the circuit breaker to open. The circuit breakers shall be quick make, and quick break on manual as well as automatic operation and shall have inverse time trips. Circuit breakers shall have the short circuit interrupting ratings indicated on the drawings.

C. Interiors shall be assembled on reinforced mounting pans or rails which provide protection against damage during handling or installation. Circuit breakers shall be assembled in accordance with the panel schedules included on the drawings. Design shall permit replacement of individual breakers without disturbing adjacent units or without disturbing main bus or branch circuit connectors. Interior design shall permit changing of branch circuits or the addition of circuit breakers to future spaces without additional machining, drilling, or tapping. Main bus bars and branch circuit connectors shall be made of copper. In-and-out adjustments of the panel interior shall be provided.

D. Panel bussing shall be arranged to maintain sequence phasing throughout, that is, adjacent poles shall be of unlike polarity and rotated in sequence. Circuit members shall be provided for each pole space or breaker space as shown on the panel schedule.

E. Cabinets shall be manufactured in accordance with Underwriters' Laboratories, Inc., standard for Cabinets and Boxes (UL 50) and shall provide a minimum of four inches wiring gutter on all sides. Cabinet fronts shall include doors with semi-concealed hinges, combination lock and catch on doors and a directory frame with circuit directory behind clear plastic, mounted on back of door. The front shall be attached to the box with suitable provision to provide proper alignment of trims.

F. Residential load centers shall not be accepted in lieu of panelboards.

### 2.8 Remote Control Stations

A. Remote pilot operators such as start-stop push buttons, HOA selector switches, pilot lights and the like shall be heavy-duty, NEMA-4 devices mounted in a NEMA-4X Stainless Steel or aluminum. Conduit entry shall be hub connected.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

A. Follow manufacturer’s installation instructions. Set line-ups in place and shim level. Bolt rails to concrete with ½” diameter stainless steel concrete anchors.
B. Bottom conduits entries into cubicles shall be carefully arranged and set in manufacturer’s allotted openings. Each conduit terminus shall be equipped with insulating grounding bushing.

C. Top conduit entries into cubicles shall enter to correct section to minimize cross wiring. Each conduit entry shall be equipped with bushing.

D. All cables inside enclosures shall be neatly arranged, bundled, and bound with plastic tie-wraps.

E. Tighten all wire and busbar connectors to factory recommended torque settings.

F. Apply anti-corrosive compound equal to Kopr-Shield to all wire terminations.

END OF SECTION
SECTION 16301 - OVERCURRENT PROTECTIVE DEVICE SHORT-CIRCUIT STUDY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS – Not used

1.2 SUMMARY

A. Section includes a computer-based, fault-current study to determine the minimum interrupting capacity of circuit protective devices. This study shall be provided for the service, standby generator, ATS and distribution system that powers the ozone system.

1.3 DEFINITIONS

A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

B. One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.

C. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.

D. SCCR: Short-circuit current rating.

E. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

1.4 ACTION SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Other Action Submittals: Submit the following after the approval of system protective devices submittals. Submittals shall be in digital form.

1. Short-circuit study input data, including completed computer program input data sheets.

2. Short-circuit study and equipment evaluation report; signed, dated, and sealed by a qualified professional engineer.

   a. Submit study report for action prior to receiving final approval of the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Engineer for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.
b. Revised single-line diagram, reflecting field investigation results and results of short-circuit study.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Short-Circuit Study Software Developer Short-Circuit Study Specialist Field Adjusting Agency.

1.6 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.

B. Short-Circuit Study Specialist Qualifications: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Easy Power - Preferred
2. ETAP.
3. SKM Systems Analysis, Inc.

B. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output.

2.2 SHORT-CIRCUIT STUDY REPORT CONTENTS

A. Executive summary.

B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of the computer printout.

C. One-line diagram, showing the following:

1. Protective device designations and ampere ratings.
2. Cable size and lengths.
3. Transformer kilovolt ampere (kVA) and voltage ratings.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, motor-control center, and panelboard designations.
D. Comments and recommendations for system improvements, where needed.

E. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short-circuit ratings.
2. Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short-circuit duties.
3. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
4. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
5. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

F. Short-Circuit Study Output:

1. Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
   a. Voltage.
   b. Calculated fault-current magnitude and angle.
   c. Fault-point X/R ratio.
   d. Equivalent impedance.

2. Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
   a. Voltage.
   b. Calculated symmetrical fault-current magnitude and angle.
   c. Fault-point X/R ratio.
   d. Calculated asymmetrical fault currents:
      1) Based on fault-point X/R ratio.
      2) Based on calculated symmetrical value multiplied by 1.6.
      3) Based on calculated symmetrical value multiplied by 2.7.

3. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
   a. Voltage.
   b. Calculated symmetrical fault-current magnitude and angle.
   c. Fault-point X/R ratio.
   d. No AC Decrement (NACD) ratio.
   e. Equivalent impedance.
   f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
   g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Obtain all data necessary for the conduct of the study.
   1. Verify completeness of data supplied on the one-line diagram. Call any discrepancies to the attention of Engineer.
   2. For equipment provided that is Work of this Project, use characteristics submitted under the provisions of action submittals and information submittals for this Project.
   3. For equipment that is existing obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers. The qualifications of technicians and engineers shall be qualified as defined by NFPA 70E.

B. Gather and tabulate the following input data to support the short-circuit study. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study.
   1. Product Data for Project's overcurrent protective devices involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
   2. Obtain electrical power utility impedance at the service.
   3. Power sources and ties.
   4. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
   5. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
   6. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip, SCCR, current rating, and breaker settings.
   7. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
   8. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
   9. Motor horsepower and NEMA MG 1 code letter designation.
  10. Cable sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).

3.2 SHORT-CIRCUIT STUDY

A. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

B. The calculations shall include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and shall apply to low- and medium-voltage, three-phase ac systems. The calculations shall also account for the fault-current dc decrement, to address the asymmetrical requirements of the interrupting equipment.
1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.

C. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each of the following:

1. Electric utility's supply termination point.
2. Incoming switchgear.
3. Unit substation primary and secondary terminals.
4. Low-voltage switchgear.
5. Motor-control centers.
6. Control panels.
7. Standby generators and automatic transfer switches.
8. Branch circuit panelboards.
9. Disconnect switches.

3.3 ADJUSTING

A. Make minor modifications to equipment as required to accomplish compliance with short-circuit study.

3.4 DEMONSTRATION

A. Train Owner's operating and maintenance personnel in the use of study results.

END OF SECTION 16301
SECTION 16302- OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS – Not used

1.2 SUMMARY

A. Section includes computer-based, overcurrent protective device coordination studies to determine overcurrent protective devices and to determine overcurrent protective device settings for selective tripping.

1. Study results shall be used to determine coordination of series-rated devices.

2. This study shall be provided for the service, standby generator, ATS and distribution system that powers the ozone system.

1.3 DEFINITIONS

A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

B. One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.

C. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.

D. SCCR: Short-circuit current rating.

E. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

1.4 ACTION SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Other Action Submittals: Submit the following after the approval of system protective devices submittals. Submittals shall be in digital form.

1. Coordination-study input data, including completed computer program input data sheets.

2. Study and equipment evaluation reports.

3. Overcurrent protective device coordination study report; signed, dated, and sealed by a qualified professional engineer.
a. Submit study report for action prior to receiving final approval of the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Engineer for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.

1.5 INFORMATIONAL SUBMITTALS – Not used

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For the overcurrent protective devices to include in emergency, operation, and maintenance manuals.

1. Include the following:

a. The following parts from the Protective Device Coordination Study Report:
   1) One-line diagram.
   2) Protective device coordination study.
   3) Time-current coordination curves.

b. Power system data.

1.7 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.

B. Coordination Study Specialist Qualifications: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Software Developers:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Easy Power. (preferred)
   b. ETAP.
   c. SKM Systems Analysis, Inc.
B. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

1. Optional Features:
   a. Arcing faults.
   b. Simultaneous faults.
   c. Explicit negative sequence.
   d. Mutual coupling in zero sequence.

2.2 PROTECTIVE DEVICE COORDINATION STUDY REPORT CONTENTS

A. Executive summary.

B. Study descriptions, purpose, basis and scope. Include case descriptions, definition of terms and guide for interpretation of the computer printout.

C. One-line diagram, showing the following:
   1. Protective device designations and ampere ratings.
   2. Cable size and lengths.
   3. Transformer kilovolt ampere (kVA) and voltage ratings.
   4. Motor and generator designations and kVA ratings.
   5. Switchgear, switchboard, motor-control center, and panelboard designations.

D. Short-Circuit Study Output: As specified in "Short-Circuit Study Output" Paragraph in "Short-Circuit Study Report Contents" Article in Section 16301 "Overcurrent Protective Device Short-Circuit Study."

E. Protective Device Coordination Study:
   1. Report recommended settings of protective devices, ready to be applied in the field. Use manufacturer's data sheets for recording the recommended setting of overcurrent protective devices when available.
      a. Phase and Ground Relays:
         1) Device tag.
         2) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.
         3) Recommendations on improved relaying systems, if applicable.
      b. Circuit Breakers:
         1) Adjustable pickups and time delays (long time, short time, ground).
         2) Adjustable time-current characteristic.
         3) Adjustable instantaneous pickup.
         4) Recommendations on improved trip systems, if applicable.
c. Fuses: Show current rating, voltage, and class.

F. Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:

1. Device tag and title, one-line diagram with legend identifying the portion of the system covered.
2. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
3. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
4. Plot the following listed characteristic curves, as applicable:
   a. Power utility's overcurrent protective device.
   b. Medium-voltage equipment overcurrent relays.
   c. Medium- and low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
   d. Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
   e. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
   f. Cables and conductors damage curves.
   g. Ground-fault protective devices.
   h. Motor-starting characteristics and motor damage points.
   i. Generator short-circuit decrement curve and generator damage point.
   j. The largest feeder circuit breaker in each motor-control center and panelboard.

5. Series rating on equipment allows the application of two series interrupting devices for a condition where the available fault current is greater than the interrupting rating of the downstream equipment. Both devices share in the interruption of the fault and selectivity is sacrificed at high fault levels. Maintain selectivity for tripping currents caused by overloads.

6. Provide adequate time margins between device characteristics such that selective operation is achieved.
7. Comments and recommendations for system improvements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.
1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 PROTECTIVE DEVICE COORDINATION STUDY

A. The study shall be based on the device characteristics supplied by device manufacturer.

B. The extent of the electrical power system to be studied is indicated on Drawings.

C. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

D. Transformer Primary Overcurrent Protective Devices:

1. Device shall not operate in response to the following:
   a. Inrush current when first energized.
   b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
   c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

E. Motor Protection:

1. Select protection for low-voltage motors according to IEEE 242 and NFPA 70.
2. Select protection for motors served at voltages more than 600 V according to IEEE 620.

F. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and protection recommendations in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

G. Generator Protection: Select protection according to manufacturer's written recommendations and to IEEE 242.

H. The calculations shall include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and shall apply to low- and medium-voltage, three-phase ac systems. The calculations shall also account for the fault-current dc decrement, to address the asymmetrical requirements of the interrupting equipment.

1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.
I. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and single line-to-ground fault at each of the following:

1. Electric utility's supply termination point.
2. Switchgear.
3. Unit substation primary and secondary terminals.
4. Low-voltage switchgear.
5. Motor-control centers.

J. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short-circuit ratings.
2. Adequacy of switchgear, motor-control centers, and panelboard bus bars to withstand short-circuit stresses.
3. Any application of series-rated devices shall be recertified, complying with requirements in NFPA 70.

3.3 LOAD-FLOW AND VOLTAGE-DROP STUDY

A. Perform a load-flow and voltage-drop study to determine the steady-state loading profile of the system. Analyze power system performance two times as follows:

1. Determine load-flow and voltage drop based on full-load currents obtained in "Power System Data" Article.
2. Determine load-flow and voltage drop based on 80 percent of the design capacity of the load buses.
3. Prepare the load-flow and voltage-drop analysis and report to show power system components that are overloaded, or might become overloaded; show bus voltages that are less than as prescribed by NFPA 70.

3.4 MOTOR-STARTING STUDY

A. Perform a motor-starting study to analyze the transient effect of the system's voltage profile during motor starting. Calculate significant motor-starting voltage profiles and analyze the effects of the motor starting on the power system stability.

B. Prepare the motor-starting study report, noting light flicker for limits proposed by IEEE 141 and voltage sags so as not to affect the operation of other utilization equipment on the system supplying the motor.

3.5 POWER SYSTEM DATA

A. Obtain all data necessary for the conduct of the overcurrent protective device study.

1. Verify completeness of data supplied in the one-line diagram on Drawings. Call discrepancies to the attention of Engineer.
2. For new equipment, use characteristics submitted under the provisions of action submittals and information submittals for this Project.

3. For existing equipment, whether or not relocated obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers. The qualifications of technicians and engineers shall be qualified as defined by NFPA 70E.

B. Gather and tabulate the following input data to support coordination study. The list below is a guide.

1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.

2. Electrical power utility impedance at the service.

3. Power sources and ties.

4. Short-circuit current at each system bus, three phase and line-to-ground.

5. Full-load current of all loads.

6. Voltage level at each bus.

7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.

8. For reactors, provide manufacturer and model designation, voltage rating, and impedance.

9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.

10. Generator short-circuit contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.

11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.

12. Maximum demands from service meters.

13. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.

14. Motor horsepower and NEMA MG 1 code letter designation.

15. Low-voltage cable sizes, lengths, number, conductor material, and conduit material (magnetic or nonmagnetic).

16. Medium-voltage cable sizes, lengths, conductor material, and cable construction and metallic shield performance parameters.

17. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:

   a. Special load considerations, including starting inrush currents and frequent starting and stopping.

   b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.

   c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.

   d. Generator thermal-damage curve.

   e. Ratings, types, and settings of utility company's overcurrent protective devices.

   f. Special overcurrent protective device settings or types stipulated by utility company.
g. Time-current-characteristic curves of devices indicated to be coordinated.

h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.

i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.

j. Panelboards, switchboards, motor-control center ampacity, and SCCR in amperes rms symmetrical.

k. Identify series-rated interrupting devices for a condition where the available fault current is greater than the interrupting rating of the downstream equipment. Obtain device data details to allow verification that series application of these devices complies with NFPA 70 and UL 489 requirements.

3.6 FIELD ADJUSTING

A. Adjust relay and protective device settings according to the recommended settings provided by the coordination study. Field adjustments shall be completed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.

B. Make minor modifications to equipment as required to accomplish compliance with short-circuit and protective device coordination studies.

3.7 DEMONSTRATION

A. Engage the Coordination Study Specialist to train Owner's maintenance personnel in the following:

1. Acquaint personnel in the fundamentals of operating the power system in normal and emergency modes.

2. Hand-out and explain the objectives of the coordination study, study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpreting the time-current coordination curves.

3. Adjust, operate, and maintain overcurrent protective device settings.
SECTION 16303

OVERCURRENT PROTECTIVE DEVICE ARC-FLASH STUDY

PART 1 GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

1.2 SUMMARY
   A. Section includes a computer-based, arc-flash study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment.
   B. This study shall be provided for the service, standby generator, ATS and distribution system that powers the ozone system.

1.3 DEFINITIONS
   A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.
   B. One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
   C. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.
   D. SCCR: Short-circuit current rating.
   E. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

1.4 ACTION SUBMITTALS
   A. Product Data: For computer software program to be used for studies.
   B. Coordinate "Study Submittals" Paragraph below with qualification requirements retained in "Quality Assurance" Article.
   C. Study Submittals: Submit the following submittals after the approval of system protective devices submittals. Submittals shall be in digital form.
1. Arc-flash study input data, including completed computer program input data sheets.

2. Arc-flash study report; signed, dated, and sealed by a qualified professional engineer.
   a. Submit study report for action prior to receiving final approval of the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Engineer for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.

1.5 INFORMATIONAL SUBMITTALS – Not used

1.6 CLOSEOUT SUBMITTALS – Not used

1.7 QUALITY ASSURANCE
   A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.
   B. Arc-Flash Study Software Developer Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
   C. Arc-Flash Study Specialist Qualifications: Professional engineer in charge of performing the study, analyzing the arc flash, and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1. Easy Power. (preferred)
      2. ETAP.
      3. SKM Systems Analysis, Inc.

2.2 ARC-FLASH STUDY REPORT CONTENT
   A. Executive summary.
B. Study descriptions, purpose, basis and scope.

C. One-line diagram, showing the following:
   1. Protective device designations and ampere ratings.
   2. Cable size and lengths.
   3. Transformer kilovolt ampere (kVA) and voltage ratings.
   4. Motor and generator designations and kVA ratings.
   5. Switchgear, switchboard, motor-control center and panelboard designations.

D. Study Input Data: As described in "Power System Data" Article.

E. Short-Circuit Study Output: As specified in "Short Circuit Study Output" Paragraph in "Short-Circuit Study Report Contents" Article in Section 16301 "Overcurrent Protective Device Short-Circuit Study."

F. Protective Device Coordination Study Report Contents: As specified in "Protective Device Coordination Study Report Contents" Article in Section 16302 "Overcurrent Protective Device Coordination Study."

G. Arc-Flash Study Output:
   1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
      a. Voltage.
      b. Calculated symmetrical fault-current magnitude and angle.
      c. Fault-point X/R ratio.
      d. No AC Decrement (NACD) ratio.
      e. Equivalent impedance.
      f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
      g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

H. Incident Energy and Flash Protection Boundary Calculations:
   1. Arcing fault magnitude.
   2. Protective device clearing time.
   3. Duration of arc.
   5. Working distance.
   6. Incident energy.

I. Fault study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of the computer printout.
2.3 ARC-FLASH WARNING LABELS

A. Produce a 3.5-by-5-inch (76-by-127-mm) self-adhesive equipment label for each work location included in the analysis.

B. The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:

1. Location designation.
2. Nominal voltage.
3. Flash protection boundary.
4. Incident energy.
5. Working distance.
6. Engineering report number, revision number, and issue date.

C. Labels shall be machine printed, with no field-applied markings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

3.2 ARC-FLASH HAZARD ANALYSIS

A. Calculate per IEEE 1584 for hazard analysis study.

B. Preparatory Studies:

1. Short-Circuit Study Output: As specified in "Short-Circuit Study Output" Paragraph in "Short-Circuit Study Report Contents" Article in Section 16301 "Overcurrent Protective Device Short-Circuit Study."

2. Protective Device Coordination Study Report Contents: As specified in "Protective Device Coordination Study Report Contents" Article in Section 16302 "Overcurrent Protective Device Coordination Study."

C. Calculate maximum and minimum contributions of fault-current size.

1. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume no motor load.
2. The maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.

D. Calculate the arc-flash protection boundary and incident energy at locations in the electrical distribution system where personnel could perform work on energized parts.

E. Safe working distances shall be specified for calculated fault locations based on the calculated arc-flash boundary, considering incident energy of 1.2 cal/sq.cm.
F. Incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators shall be decremented as follows:

1. Fault contribution from induction motors should not be considered beyond three to five cycles.
2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g., contributions from permanent magnet generators will typically decay from 10 per unit to three per unit after 10 cycles).

G. Arc-flash computation shall include both line and load side of a circuit breaker as follows:

1. When the circuit breaker is in a separate enclosure.
2. When the line terminals of the circuit breaker are separate from the work location.

H. Base arc-flash calculations on actual overcurrent protective device clearing time.

3.3 POWER SYSTEM DATA

A. Obtain all data necessary for the conduct of the arc-flash hazard analysis.

1. Verify completeness of data supplied on the one-line diagram on Drawings. Call discrepancies to the attention of Engineer.
2. For new equipment, use characteristics submitted under the provisions of action submittals and information submittals for this Project.
3. For existing equipment, whether or not relocated, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers.

B. Electrical Survey Data: Gather and tabulate the following input data to support study. Comply with recommendations in IEEE 1584 and NFPA 70E as to the amount of detail that is required to be acquired in the field.

1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Obtain electrical power utility impedance at the service.
3. Power sources and ties.
4. Short-circuit current at each system bus, three phase and line-to-ground.
5. Full-load current of all loads.
6. Voltage level at each bus.
7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in per cent, and phase shift.
8. For reactors, provide manufacturer and model designation, voltage rating and impedance.
9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
12. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
13. Motor horsepower and NEMA MG 1 code letter designation.
14. Low-voltage cable sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
15. Medium-voltage cable sizes, lengths, conductor material, and cable construction and metallic shield performance parameters.

3.4 LABELING

A. Apply one arc-flash label for 600-V ac, 480-V ac, and applicable 208-V ac panelboards and disconnects and for each of the following locations:
   1. Motor-control center.
   2. Low-voltage switchboard.
   3. Switchgear.
   4. Medium-voltage switch.
   5. Control panel.

3.5 APPLICATION OF WARNING LABELS

A. Install the arc-fault warning labels under the direct supervision and control of the Arc-Flash Study Specialist.

3.6 DEMONSTRATION

A. Engage the Arc-Flash Study Specialist to train Owner’s maintenance personnel in the potential arc-flash hazards associated with working on energized equipment and the significance of the arc-flash warning labels.

END OF SECTION 16303
PART 1 GENERAL

1.1 QUALITY ASSURANCE – Not used

PART 2 MATERIALS

2.1 AVIATION OBSTRUCTION LIGHTING (Not used)

2.2 VARIABLE FREQUENCY DRIVES – Not used

2.2 LIGHTING FIXTURES

A. Lighting fixtures shall be furnished as described or detailed on the drawings and as specified under this section.

B. Fixture lamps shall be furnished as scheduled. Incandescent lamps shall be 130V inside frosted type; fluorescent lamps shall be cool-white; H.I.D lamps shall be metal halide deluxe white; unless other styles are specified.

C. Each fixture shall be complete with its appropriate hardware, finish trims, and appurtenances as required for a finished installation.

2.3 SPACE HEATERS – Not used

2.4 HEAT TRACING

Where specified on the plans, exposed piping, valves, or equipment shall be provided with freeze protection. The freeze protection shall consist of self-limiting type tracers and 1” of insulation. The heating cable shall be designed to keep the contained fluid at 40°F on a 0°F day in a 20 mph wind. The heating cable shall be suitable for 110 VAC single phase operation and ON-OFF switches for the tape shall be provided at each area of piping or equipment. The insulation shall be as specified except that preformed insulation must be oversized to allow for the heating cable.

2.5 INDUCTION MOTORS

A. Provide motors designed and applied in compliance with NEMA, ANSI, IEEE, and NEC for specific duty imposed by driven equipment.

B. Where frequent starting occurs, furnish motors designed for frequent starting duty equivalent to duty service required by driven equipment.
C. Unless recognized and defined by the standards and codes for intermittent duty as a standard industry practice, rate all motors for continuous duty at 40°C ambient. Motor temperature rise above 40°C ambient for continuous operation at nameplate horsepower shall not exceed NEMA limit for 1.0 service factor and Class B insulation, or other recognized NEMA class insulation.

D. Design motors for full voltage starting. In addition, design motors for other than full voltage starting when specified. Provide VFD duty motors when the motor is to be powered from a VFD. This includes VFD rated motor winding insulation, 1.15 service factor, insulated bearings on both ends and an Aegis (brushless) shaft grounding bearing protection ring. The use of special high frequency cables shall not be required to power and ground the VFD rated motor. Motors bearings that fail due to fluting of the bearings shall be replaced at no cost with motors having bearings that do not fail due to fluting of the bearings.

E. Design motor bearing life based upon actual operating load conditions imposed by the driven equipment.

F. Size motors for altitude at location where equipment is to be installed.

G. Except where specific horsepower limits are specified, size motors so that under maximum continuous load imposed by driven equipment, motor nameplate horsepower for continuous operation in 40°C ambient, is a minimum of 15 percent more than driven load.

H. Where required, provide motors with a sealed insulation system designed for a more severe environment than usual varnish treatments can withstand. Insulation system shall be NEMA Class F minimum.

I. Furnish motors with clamp-type terminals inside the motor conduit box.

J. Furnish motors with oversized external conduit boxes.

K. Not used

1. Not used

M. Not used

N. Provide motor data as follows with submittals

1. Manufacturer, type, horsepower, RPM, enclosure, and voltage.

2. Insulation and temperature rise.

3. Efficiency at full, ¾, and ½ full load.

4. Power factor at full, ¾, and ½ full load.

5. Bearing data.


7. Motor weight.
8. Warranty.

9. Service center location.

O. Provide motor identification plate as follows:

1. Laminated phenolic engraving stock 3”H X 6”L X .062” thick, black background with white 3/8” letters attached to the motor with tyrap tie.

2. Identify motor per contract drawings/specifications.

PART 3 EXECUTION

Not Used.

END OF SECTION
SECTION 16500

INSTRUMENTATION DEVICES

PART 1 GENERAL

1.1 SUMMARY

A. This section of the Electrical and Instrument division of specifications is a supplement to the equipment sections, to other electrical specifications, and to the electrical drawings.

B. Except as otherwise indicated, details of control wiring required for instrumentation are not shown; however, determine the requirements and install all wiring as required under those sections.

1.2 SYSTEM DESCRIPTION

A. The instrumentation shall monitor and control the operation of an ozone treated water system, which includes Lake Diversion gravity flow lines, Lake Diversion pumped water lines, ozone generation equipment, ozone contact basin (reactor) level and flow and related devices. See specification 11200 for instrumentation provided by the ozone equipment manufacturer.

B. A complete instrumentation system shall be provided. This includes wiring and miscellaneous devices to interconnect all instrumentation for this project.

C. Oscillation of final control element shall not exceed two cycles per minute or 0.5% full travel in response to change in controller setpoint or corrective action to hold controller setpoint.

D. Final control elements shall stabilize within 30 seconds when responding to controller output changes and shall repeat to within 0.5% of full range.

E. Controllers shall control to within 1.0% of full range.

1.3 SUBMITTALS

A. Provide OWNER a written statement verifying that instrumentation has been installed and commissioned in accordance with manufacturer’s instructions, calibrated to National Bureau of Standards specifications, and that it is ready for use by the OWNER.

B. Process and instrument diagrams conforming to ISA 55.1

C. Completed ISA Data Sheets for each instrument tagged in accordance with OWNER’S P&I Diagrams.

1.4 QUALITY ASSURANCE

A. Manufacturer’s, installers, and system integrators shall have at least five years of experience in ozone and SCADA system instrumentation.

B. SCADA – See specification 16700
1.5  WARRANTY – Not used

1.6  OWNER’S INSTRUCTIONS

On-site instruction of owner’s operating personnel for 8 hours at the job site shall be provided at the conclusion of final checkout and startup. Instruction shall include proper operation and maintenance of instrumentation.

1.7  COMMISSIONING

A. The CONTRACTOR shall employ, contract, and pay for services of an instrumentation subcontractor to install, calibrate and commission instrumentation and control loops.

B. Calibrate and commission control loops from primary element to final control element. Calibration shall include simulating control signals at input terminals of control loop elements proportional to the range of the process variable being measured. Set zero and span of all control elements to conform to simulated inputs signals.

C. Commissioning shall include verification that each element of the control loops function throughout their specified range.

D. Provide equipment for calibration of each control loop element, which is certified by the National Bureau of Standards.

E. Tune all control loops to provide straight-line control under dynamic conditions.

F. Conduct instrumentation startup.

G. Perform necessary modifications to instrumentation to assure proper operation.

1.8  MAINTENANCE – Not used

PART 2 PRODUCTS

2.1  Signals shall be 4-20 mA, 24v direct current with ungrounded negative.

2.2  INPUTS – SENSORS & TRANSMITTERS

A. FLOW – Magnetic flow meter FE/FIQT-1102 shall be provided. See specification 13420.

B. TEMPERATURE – Not used

C. PRESSURE - Not used

D. LEVEL – See specification 13421 for ozone contact basin (reactor) level indicating transmitter LIT-1101
E. OTHER

1. HAND SWITCHES:
   a. Furnish and install hand switches to locations shown on the Plans. (Open, Close, Start, Stop, Selector Switch, HOA, LOR, etc.)
   b. Provide each switch with sufficient number of contacts and pushbuttons to perform functions. Provide switches as shown on the Plans. Furnish switches with engraved legend plate and nameplate. Provide switches of heavy duty oil tight construction.

2. POSITION SWITCHES:
   a. Intruder switches shall be provided on all doors. Switches shall be wired in series to provide one switching point for remote security alarms. Switches shall be rated 300 vac, 5 amp resistive, and of a non-contact design (magnetic reed switch.)
   b. Limit switches shall be provided where required on the drawings. Limit switches shall be rated 300 vac, 5 amp resistive, of a non-contact design (magnetic reed switch), rated for outdoor use, hermetically sealed, and installed in an adjustable holder.

2.3 DATA MANIPULATION

Each signal shall be provided with Transient Voltage Surge Suppression at the input/output terminals of its monitor or controller.

A. Converters

1. Furnish and install converters to locations shown on the Plans and suitable for applications shown and specified. Coordinate converters with applicable elements in control loops. Converters shall include current-to-current converters for conversion of pulse frequency signals to 4-20 mAdc signals, and 4-20 mA to 4-20 mA.

2. Provide current-to-current converters capable of converting a 4-20 mAdc signal to a 4-20 mAdc signal. Furnish a unit of all solid state design and which will provide electrical isolation by means of a magnitude amplifier. Coordinate units fully with equipment specified for the control functions.

3. Not used

4. Furnish unit as manufactured by AGM Electronics, Inc. Moore Products, Moore Industries, or equal.

B. Controllers

1. PID (proportional, integral & differential) closed loop controllers shall be configured in the SCADA system for control of the ozone contact basin (reactor) and treated water flow. LIC-1101 shall control reactor basin level by adjusting the position of motor operated level valve LV-1101. FIC-1102
shall limit flow to not greater than 2000 gpm by adjusting motor operated valve FV-1102.

C. Indicators

1. Indicators shall be configured in the SCADA system at the water treatment plant as shown on the process and instrument diagrams.

2. Local and panel indicator lights shall be LED style construction and of the color indicated on the plans.

D. Analyzers – Ozone analyzers AIT-906, AIT-1104 and AIT-1105 shall be provided under specification 11200. Ozone production equipment manufacturer shall provide sample pump for AIT-1104 and AIT 1105. Sample pump shall operate from 230-vac, single phase, 60 Hz.

E. SCADA – See specification 16700 for SCADA

2.4 INPUT/OUTPUT STATION – Not used

2.5 INTERFACE UNIT

The biologist office shall be provided with a work station (laptop PC) software and communications hardware to communicate with the ozone production PLC and remotely monitor and control the ozone treatment system.

2.6 TELEMETRY

The ozone production building shall be provided with a FHSS (frequency hopping spread spectrum) non-licensed radio, antenna tower (mast) and omni-directional antenna to communicate with the ozone production system PLC, the Lake Diversion RTU (remote terminal unit) and the biologist office HMI/work station. The RTU at the Lake Diversion pump control panel shall be provided with a FHSS radio, antenna mast and directional antenna. The biologist office HMI/work station shall be provided with a FHSS radio, antenna mast and directional antenna.

2.7 RADIO TOWER (Not used)

2.8 OUTPUTS

Provide outputs as shown on the plans.

2.9 CONTROL AUXILIARIES

A. The items to be furnished and installed under this section of the Specifications consist of all control auxiliaries as shown on the drawings and as specified, including any equipment, accessories, and appurtenances necessary for a complete and operable system.

B. Items required in the project include but are not necessarily limited to the following: Hand Switches, Relays, Converters, Control Panels, and Miscellaneous Supplies.
C. Control auxiliaries meeting these specifications shall be as manufactured by Foxboro, Moore Industries, Moore Products, Vitran, Micro Switch, Square-D, or equal. Various individual items described in paragraphs following may contain requirements different from the manufacturers listed in this paragraph. The requirements listed in the various paragraphs shall control.

2.10 ENCLOSURES

Each instrument and control device shall be furnished with an enclosure suitable for the environment into which it is to be located. Enclosures shall be NEMA or IP rated as called out in the plans or other specifications.

Instruments with indicators located outdoors shall be rated for use in direct sunlight or the instrument shall be provided with an O’Brien / Ametek ExB sunshade or engineer approved equal.

Control panels located outdoors shall be provided with enclosures having a dead front door behind which another swing-out door is located. Operator interface indicators, switches and other devices to be monitored or manipulated by the operator shall be located on this inner swing-out door. All other components that require qualified electricians to maintain shall be located on a fixed panel behind the swing-out door. Dead front enclosures shall be Saginaw SCE-xxELxxxxAA6PPL / SCE-SFxxEDxxLP or engineer approved equal.

Outdoor enclosures shall be 316 stainless steel, with 3-point pad-lockable door operators, interior print pocket, drains, breathers, vents, thermostatically controlled anti-condensate heaters, thermostatically controlled ventilation fans and rated NEMA 3R /12.

2.11 CONTROL PANELS

A. Furnish and install control panels as shown on the Plans. All instrumentation, control modules, and accessory equipment shall be housed in control panels as indicated.

B. Instrumentation, status lights, and control components shall be mounted on removable back panels. All equipment relays, etc. necessary to perform the functions shall be located in the control panel and shall be mounted on an inner rack available through a door to afford maximum ease of inspection and servicing.

C. All equipment placed in the above described control panels shall be completely wired and electrically complete with all internal wiring terminating at terminal boards.

D. Each major element of the system located within a control panel shall be identified by a nameplate. Nameplates include, but are not limited to, relays, time delay assemblies, control assemblies, switches, and variable adjustment.

E. For ease of servicing and maintaining the equipment, all inter-unit wiring shall be color coded, using solderless pressure connections when any wire is fastened to any open relay, timer, or terminal block. All conductors shall be cabled in groups and supported so as to prevent breaking and to present a neat appearance. All out-going wiring shall be at least #14, and all terminal connections shall be numbered consecutively throughout the system. Where possible, wires shall be
grouped together in easily disassembled bundles for ease of access to the various instruments housed in each cabinet and each major component shall be independently fused. Unsightly wiring will be a basis for rejection of any work under this Specification.

F. Not used

G. Where 120-vac control power is used, the panel shall be provided with a mode selector switch. This mode selector switch shall be arranged to disconnect and isolate the control circuits from the control power transformer. In the test mode position the control circuits will be powered by connecting a separate 120-vac source to a pigtailed plug. This will allow qualified electricians to work on the control circuits without being exposed to the power circuit.

H. Each equipment control panel (local control panel) shall be provided with a local disconnecting means adjacent to the equipment control panel. Each equipment control panel equipment control panel shall be provided with an UL 1436 listed and labelled absence of voltage tester wired to power terminals located where power first enters the control panel. The absence of voltage tester shall be mounted through the door of the control panel adjacent to the enclosure’s pad lockable hasp. Absence of voltage tester shall be Panduit VeriSafe or engineer approved equal.

PART 3 EXECUTION

3.1 INTERFACE WITH OTHER WORK (Not used)

3.2 ADJUSTING (Not used)

3.3 DEMONSTRATION

Demonstrate proper function of all modes of operation, failure and features to the satisfaction of the owner’s and engineer’s representatives.

END OF SECTION
SECTION 16600

CONTROL NARRATIVES

PART 1 GENERAL – This specification is supplemental to specification 11200 ozone Generator System & 16700 SCADA System.

PART 2 PRODUCTS

2.1 ALARMS

A. Alarms conditions shall be on open contact (broken wire sounds alarm.) Alarms shall be provided as shown on the P&I Diagram. Alarms shall be integrated into logical displays, shall be provided with a first out alarm sequence, audible and visual indication of status, and acknowledgement of alarm condition. Reset of alarm shall occur when the condition driving the alarm has returned to normal. Alarm set-points shall be operator adjustable when derived from other than status contacts.

B. Alarms shall be provided for pre-shutdown and shutdown as needed (determined by Ozone equipment manufacturer) for safe and reliable operation of the ozone related equipment.

2.2 INDICATORS

A. Indicators shall be integrated into logical displays.

B. Indicators shall be provided as needed (determined by Ozone equipment manufacturer) to monitor critical functions of the ozone related equipment and as shown in the P&I diagrams.

2.3 CONTROLS

The ozone generation equipment shall be automatically or manually operated. TPW hatchery operator(s) shall set a minimum flow trigger rate at the ozone MCP (main control panel) which is located in the Ozone Seatainer. When flow rate is above the operator selected rate, then the ozone equipment will automatically start and stop based on flow rate.

In manual mode the TPW hatchery operator starts or stops the ozone generation equipment by switch at the ozone MCP, which is located in the Ozone Seatainer.

The remainder of the controls description provided below is not for the ozone MCP in the Seatainer. What follows is for ozone system operation from Lake Diversion to the pond(s) either via the gravity flow line, via the line fed from the floating pumps or by both.

A. GRAVITY FLOW FROM LAKE DIVERSION MODE
   a. INITIAL CONDITIONS
      i. Ozone generation equipment is off.
      ii. The bypass valve HV-904 is closed
      iii. All block valves from Lake Diversion along the gravity line to the ozone generation equipment are open.
      iv. All block valves from Lake Diversion along the pumped line to the ozone generation equipment are closed and the floating pumps are off.
v. The ozone reactor (tank) is empty.
vi. Hand switch HS-1102 is set to the closed position, flow valve FV-1102 is fully closed and ZSL-1102 confirms that FV-1102 is closed.
vii. All pond valves are fully closed.
b. Hatchery operator opens valves HV-905 and HV-907 and in that order. Flow is detected at FIT-1102 and relayed to the ozone generation equipment via FY-1102, which starts the ozone generation equipment. LV-1101 is fully open and the ozone reactor (tank) begins to fill. Flow is totalized and recorded via FQR-1102. Flow rate is also indicated via FIC-1102. The ozone reactor fills, level valve LV-1101 goes fully closed and the ozone reactor tank stops filling.
c. Flow meter FIT-1102 shall be a magnetic type meter. Magnetic flow meters along with most other flow meters required that the pipe in which the meter is located always be full in order to obtain an accurate indication of flow rate. Maintenance of piping systems or the meter may occasionally result in less than a full meter or pipe. Always check piping vents to insure a full meter.
d. Ozone generation equipment is limited to flow rates between 789 gpm and 2000 gpm. Hatchery operator adjustable low flow alarm FAL-1102 and high flow alarm FAH-1102 shall be provided. Alarms will remain on until acknowledged by the operator and remain visible until the flow rate condition is between the low and high flow rate alarm trigger points.
e. Hatchery operator opens desired pond(s) valve(s).
f. Hatchery operator changes position of hand switch HS-1102 to remote.
g. Flow controller FIC-1102 drives flow valve FV-1102 fully open. Level drops in ozone reactor. Level transmitter LIT-1101 detects the drop in the ozone reactor. Level controller LIC-1101 drives level control valve LV-1101 open just enough to maintain level in ozone reactor thereby matching the flow into the reactor to the flow out of the reactor.
h. When flow valve FV-1102 is fully open, then position light ZLL-1102 shall illuminate. When flow valve FV-1102 is fully closed, then position light ZLH-1102 shall illuminate. When FV-1102 is neither fully open nor fully closed, then neither position light will illuminate and FV-1102 is adjusting its position to control flow rate to below 2000 gpm.
i. Pond(s) fill.
j. If at any time, the flow exceeds 2000 gpm to the ponds, then flow meter FIT-1102 detects flow in excess of the ozone generation equipment rated capacity and informs flow controller FIC-1102. Flow controller FIC-1102 drives flow valve FV-1102 just enough less than fully open to limit flow to not exceed 2000 gpm.
k. Hatchery operator observes pond(s) level(s) and closes / opens pond(s) valve(s) as desired until all pond(s) are at hatchery operator desired level(s). Level controller LIC-1102 automatically adjusts to flow into the ozone reactor as the pond(s) valve(s) are being opened and closed to maintain a full ozone reactor tank.
m. If at any time the flow drops below 729 gpm, then the ozone generation equipment’s MCP (main control panel) via the flow-pacing signal provided by FY-1102 detects flow below 729 gpm and turns off the ozone generation equipment. Ozone generation equipment is automatically turned on when flow returns to above 729 gpm.
n. Dissolved ozone is monitored continuously at the outlet of the ozone reactor by AIT-1104 and AIT-1105, a redundant pair of analyzers. Analyzer results are indicated locally and are also indicated and recorded by AIR-1104 and AIR-1105. Each dissolved ozone analyzer is provided with a high-ozone presence switch. If either switch ASHH-1104 or switch ASHH-1105 detects unreacted (dissolved ozone), then flow valve FV-1102 fully closes.
dissolved ozone analyzers require 30-sends to detect dissolved ozone. The time required to fully close FV-1102 from the fully open position shall not exceed 30 seconds resulting in system interlock response time not to exceed 60-seconds.

o. Fully closing of FV-1102 occurs regardless of the position (open, closed or remote) of switch HS-1102. This is a hardwired safety interlock to prevent ozone poisoning of the ponds. Hatchery operator adjustable alarms AAH-1104 and AAH-1105 shall be triggered to advise the hatchery operator when this safety interlock has been activated. Reset of this safety interlock will occur automatically when ozone analyzers AIT-1104 and AIT-1105 no longer detect the presence of dissolved ozone. When reset of this safety interlock occurs, then flow valve FV-1102 will automatically open and filling of the ponds will resume. Alarm(s) AAH-1104 and or AAH-1105 will remain on until the hatchery operator acknowledges the alarms and the alarm condition has cleared.

p. Hatchery operator closes all pond(s) valve(s). Flow to pond(s) stops. Ozone reactor (tank) level holds at filled level. Ozone generation equipment stops producing ozone.

q. Gravity flow from Lake Diversion mode ready for use again.

B. PUMPED FLOW FROM LAKE DIVERSION MODE

a. INITIAL CONDITIONS
   i. Floating pumps will provide sufficient head and a flow rate of at least 729 gpm.
   ii. Ozone generation equipment is off.
   iii. The bypass valve HV-904 is closed.
   iv. All block valves from Lake Diversion along the gravity line to the ozone generation equipment are closed.
   v. All block valves from Lake Diversion along the pumped line to the ozone generation equipment are open and the floating pumps are off.
   vi. The ozone reactor (tank) is empty.
   vii. Hand switch HS-1102 is set to the closed position, flow valve FV-1102 is fully closed and ZSL-1102 confirms that FV-1102 is closed.
   viii. All pond valves are fully closed.

b. Hatchery operator starts floating pumps. Existing pump controls provide a local start/stop switch for each pump. This project shall provide additional radio telemetered remote start/stop capability. Start/stop switch JS-901 shall be provided at the biologist office via radio telemetry to start/stop one floating pump. Start/stop switch JS-902 shall be provided at the biologist office via radio telemetry to start/stop a second floating pump. JL-901 shall be provided at the biologist office via radio telemetry to indicate one floating pump is running. JL-902 shall be provided at the biologist office via radio telemetry to indicate the second floating pump is running.

c. Hatchery operator checks vent / drain valves along pumped line to insure that this line is full.

d. Hatchery operator opens valves HV-905 and HV-907 and in that order. Flow is detected at FIT-1102 and relayed to the ozone generation equipment via FY-1102, which starts the ozone generation equipment. LV-1101 is fully open and the ozone reactor (tank) begins to fill. Flow is totalized and recorded via FQR-1102. Flow rate is also indicated via FIC-1102. The ozone reactor fills, level valve LV-1101 goes fully closed and the ozone reactor tank stops filling.

e. Flow meter FIT-1102 shall be a magnetic type meter. Magnetic flow meters along with most other flow meters required that the pipe in which the meter is located always be full in order to obtain an accurate indication of flow rate.
Maintenance of piping systems or the meter may occasionally result in less than a full meter or pipe. Always check piping vents to insure a full meter.

f. Ozone generation equipment is limited to flow rates between 729 gpm and 2000 gpm. Hatchery operator adjustable low flow alarm FAL-1102 and high flow alarm FAH-1102 shall be provided. Alarms will remain on until acknowledged by the operator and remain visible until the flow rate condition is between the low and high flow rate alarm trigger points.

g. Hatchery operator opens desired pond(s) valve(s).

h. Hatchery operator changes position of hand switch HS-1102 to remote.

i. Flow controller FIC-1102 drives flow valve FV-1102 fully open. Level drops in ozone reactor. Level transmitter LIT-1101 detects the drop in the ozone reactor. Level controller LIC-1101 drives level control valve LV-1101 open just enough to maintain level in ozone reactor thereby matching the flow into the reactor to the flow out of the reactor.

j. When flow valve FV-1102 is fully open, then position light ZLL-1102 shall illuminate. When flow valve FV-1102 is fully closed, then position light ZLH-1102 shall illuminate. When FV-1102 is neither fully open nor fully closed, then neither position light will illuminate and FV-1102 is adjusting its position to control flow rate to below 2000 gpm.

k. Pond(s) fill.

l. If at any time, the flow exceeds 2000 gpm to the ponds, then flow meter FIT-1102 detects flow in excess of the ozone generation equipment rated capacity and informs flow controller FIC-1102. Flow controller FIC-1102 drives flow valve FV-1102 just enough less than fully open to limit flow to not exceed 2000 gpm.

m. Hatchery operator observes pond(s) level(s) and closes / opens pond(s) valve(s) as desired until all pond(s) are at hatchery operator desired level(s). Level controller LIC-1102 automatically adjusts to flow into the ozone reactor as the pond(s) valve(s) are being opened and closed to maintain a full ozone reactor tank.

n. If at any time the flow drops below 729 gpm, then the ozone generation equipment’s MCP (main control panel) via the flow-pacing signal provided by FY-1102 detects flow below 729 gpm and turns off the ozone generation equipment. Ozone generation equipment is automatically turned on when flow returns to above 729 gpm.

o. Dissolved ozone is monitored continuously at the outlet of the ozone reactor by AIT-1104 and AIT-1105, a redundant pair of analyzers. Analyzer results are indicated locally and are also indicated and recorded by AIR-1104 and AIR-1105. Each dissolved ozone analyzer is provided with a high-ozone presence switch. If either switch ASHH-1104 or switch ASHH-1105 detects unreacted (dissolved ozone), then flow valve FV-1102 fully closes. The dissolved ozone analyzers require 30-sends to detect dissolved ozone. The time required to fully close FV-1102 shall not exceed 30 seconds resulting in system interlock response time not to exceed 60-seconds.

p. Fully closing of FV-1102 occurs regardless of the position (open, closed or remote) of switch HS-1102. This is a hardwired safety interlock to prevent ozone poisoning of the ponds. Hatchery operator adjustable alarms AAH-1104 and AAH-1105 shall be triggered to advise the hatchery operator when this safety interlock has been activated. Reset of this safety interlock will occur automatically when ozone analyzers AIT-1104 and AIT-1105 no longer detect the presence of dissolved ozone. When reset of this safety interlock occurs, then flow valve FV-1102 will automatically open and filling of the ponds will resume. Alarm(s) AAH-1104 and or AAH-1105 will remain on until the hatchery operator acknowledges the alarms and the alarm condition has cleared.
q. Hatchery operator closes all pond(s) valve(s). Flow to pond(s) stops. Ozone reactor (tank) level holds at filled level. Ozone generation equipment stops producing ozone.

r. Pumped flow from Lake Diversion mode ready for use again.

C. BYPASS OZONE GENERATION / NO OZONE TREATMENT MODE
   a. INITIAL CONDITIONS
      i. Ozone generation equipment is off.
      ii. The bypass valve HV-904 is closed
      iii. All block valves from Lake Diversion along the gravity line to the ozone generation equipment are closed.
      iv. All block valves from Lake Diversion along the pumped line to the ozone generation equipment are closed and the floating pumps are off.
      v. The ozone reactor (tank) is empty.
      vi. Hand switch HS-1102 is set to the closed position, flow valve FV-1102 is fully closed and ZSL-1102 confirms that FV-1102 is closed.
      vii. All pond valves are fully closed.
   b. Hatchery operator opens all desired block valves along the gravity line to bypass block valve HV-904.
   c. Hatchery operator opens bypass valve HV-904.
   d. Hatchery operator opens all desired block valves along the pumped 14-inch line to bypass block valve HV-904 and starts floating pumps.
   e. Hatchery operator opens / closes pond(s) valve(s) as desired.
   f. Hatchery operator observes pond(s) level(s) and closes / opens pond(s) valve(s) as desired until all pond(s) are at hatchery operator desired level(s).
   g. Hatchery operator turns off floating pumps.
   h. Hatchery operator closes all block valves along the pumped line to bypass block valve HV-904
   i. Hatchery operator closes block valves along the gravity line to bypass block valve HV-904.
   j. Hatchery operator closes bypass valve HV-904.
   k. Bypass ozone generation / no ozone treatment mode ready for use again.

D. CONCURRENT GRAVITY FLOW AND PUMPED FLOW FROM LAKE DIVERSION MODE
   a. INITIAL CONDITIONS
      i. Ozone generation equipment is off.
      ii. The bypass valve HV-904 is closed
      iii. All block valves from Lake Diversion along the gravity line to the ozone generation equipment are closed.
      iv. All block valves from Lake Diversion along the pumped line to the ozone generation equipment are closed and the floating pumps are off.
      v. The ozone reactor (tank) is empty.
      vi. Hand switch HS-1102 is set to the closed position, flow valve FV-1102 is fully closed and ZSL-1102 confirms that FV-1102 is closed.
      vii. All pond valves are fully closed.
   b. Hatchery operator opens valves HV-905 and HV-907 and in that order. Flow is detected at FIT-1102 and relayed to the ozone generation equipment via FY-1102, which starts the ozone generation equipment. LV-1101 is fully open and the ozone reactor (tank) begins to fill. Flow is totalized and recorded via FQR-1102. Flow rate is also recorded via FQR-1102. The ozone reactor fills, level valve LV-1101 goes fully closed and the ozone reactor tank stops filling.
c. Hatchery operator starts floating pumps. Existing pump controls provide a local start/stop switch for each pump. This project shall provide additional radio telemetered remote start/stop capability. Start/stop switch JS-901 shall be provided at the biologist office via radio telemetry to start/stop one floating pump. Start/stop switch JS-902 shall be provided at the biologist office via radio telemetry to start/stop a second floating pump. JL-901 shall be provided at the biologist office via radio telemetry to indicate one floating pump is running. JL-902 shall be provided at the biologist office via radio telemetry to indicate the second floating pump is running.

d. Hatchery operator checks vent / drain valves along 14-inch pumped line to insure 14-inch line is full.

e. Flow meter FIT-1102 shall be a magnetic type meter. Magnetic flow meters along with most other flow meters required that the pipe in which the meter is located always be full in order to obtain an accurate indication of flow rate. Maintenance of piping systems or the meter may occasionally result in less than a full meter or pipe. Always check piping vents to insure a full meter.

f. Ozone generation equipment is limited to flow rates between 729 gpm and 2000 gpm. Hatchery operator adjustable low flow alarm FAL-1102 and high flow alarm FAH-1102 shall be provided. Alarms will remain on until acknowledged by the operator and remain visible until the flow rate condition is between the low and high flow rate alarm trigger points.

g. Hatchery operator opens desired pond(s) valve(s).

h. Hatchery operator changes position of hand switch HS-1102 to remote.

i. Flow controller FIC-1102 drives flow valve FV-1102 fully open. Level drops in ozone reactor. Level transmitter LIT-1101 detects the drop in the ozone reactor. Level controller LIC-1101 drives level control valve LV-1101 open just enough to maintain level in ozone reactor thereby matching the flow into the reactor to the flow out of the reactor.

j. When flow valve FV-1102 is fully open, then position light ZLL-1102 shall illuminate. When flow valve FV-1102 is fully closed, then position light ZLH-1102 shall illuminate. When FV-1102 is neither fully open nor fully closed, then neither position light will illuminate and FV-1102 is adjusting its position to control flow rate to below 2000 gpm.

k. Pond(s) fill.

l. If at any time, the flow exceeds 2000 gpm to the ponds, then flow meter FIT-1102 detects flow in excess of the ozone generation equipment rated capacity and informs flow controller FIC-1102. Flow controller FIC-1102 drives flow valve FV-1102 just enough less than fully open to limit flow to not exceed 2000 gpm.

m. Hatchery operator observes pond(s) level(s) and closes / opens pond(s) valve(s) as desired until all pond(s) are at hatchery operator desired level(s). Level controller LIC-1102 automatically adjusts to flow into the ozone reactor as the pond(s) valve(s) are being opened and closed to maintain a full ozone reactor tank.

n. If at any time the flow drops below 729 gpm, then the ozone generation equipment’s MCP (main control panel) via the flow-pacing signal provided by FY-1102 detects flow below 729 gpm and turns off the ozone generation equipment. Ozone generation equipment is automatically turned on when flow returns to above 729 gpm.

o. Dissolved ozone is monitored continuously at the outlet of the ozone reactor by AIT-1104 and AIT-1105, a redundant pair of analyzers. Analyzer results are indicated locally and are also indicated and recorded by AIR-1104 and AIR-1105. Each dissolved ozone analyzer is provided with a high-ozone presence switch. If either switch ASHH-1104 or switch ASHH-1105 detects unreacted (dissolved ozone), then flow valve FV-1102 fully closes. The
dissolved ozone analyzers require 30-sends to detect dissolved ozone. The time required to fully close FV-1102 from the fully open position shall not exceed 30 seconds resulting in system interlock response time not to exceed 60-seconds.

p. Fully closing of FV-1102 occurs regardless of the position (open, closed or remote) of switch HS-1102. This is a hardwired safety interlock to prevent ozone poisoning of the ponds. Hatchery operator adjustable alarms AAH-1104 and AAH-1105 shall be triggered to advise the hatchery operator when this safety interlock has been activated. Reset of this safety interlock will occur automatically when ozone analyzers AIT-1104 and AIT-1105 no longer detect the presence of dissolved ozone. When reset of this safety interlock occurs, then flow valve FV-1102 will automatically open and filling of the ponds will resume. Alarm(s) AAH-1104 and or AAH-1105 will remain on until the hatchery operator acknowledges the alarms and the alarm condition has cleared.

q. Hatchery operator closes all pond(s) valve(s). Flow to pond(s) stops. Ozone reactor (tank) level holds at filled level. Ozone generation equipment stops producing ozone.

r. Hatchery operator stops floating pumps.

E. RESIDUAL OZONE BY PASS MODE
   a. INITIAL CONDITIONS
      i. Bypass valve HV-904 is closed.
      ii. Reactor outlet flow valve, FV-1102 is open, ozone reactor outlet box is full of treated water, ozone generator is operating in flow-paced mode.
      Raw water is being provided via the 21-inch gravity line and / or the 14-inch pumped line.
   b. Excess dissolved ozone is detected at the ozone reactor outlet, which triggers the ozone reactor outlet flow control valve, FV-1102 to go fully closed. A high ozone alarm is annunciated on the SCADA system in the biologist office.
   c. Level rises in the outlet box of the ozone reactor outlet box and level control valve LV-1101 goes fully closed. No water is flowing to the ponds.
   d. The operator may choose to open the bypass valve HV-904 by manually opening the bypass valve. Automatic opening of the bypass valve shall not be provided, since there is no automated way to determine if golden algae are present in the Lake Diversion water source.
   e. A motor operator for HV-904 with remote (SCADA) open/close switch and open/closed SCADA lights may be provided if funding allows.

F. CONTROL and MONITORING
   a. The following shall be configured in the SCADA by the ozone production facility provider:
      i. A PID (proportional plus integral plus derivative) for FIC-1102 and LIC-1101 having operator adjustable high and low SCADA alarms.
      ii. Fully open and fully closed indicator lights ZLH-1102, ZLL-1102, ZLH-904 & ZLL-904 motor operated valves.
      iii. Flow totalizing recorder FQR-1102.
      iv. Dissolved ozone analyzer indicating recorders AIR-102, AIR-1104 & AIR-1105 having operator adjustable high level alarms.
      v. Open / close MOV hand switch HS-904B for bypass MOV.
      vi. Lake pump motor start/stop switches JS-901 and JS-902
      vii. Lake pump motor run lights JL-901 and JL-902
      viii. ATS (automatic transfer switch) not in normal (SWRE Cooperative) position (standby generator running)
ix. Standby electric generator doors not fully closed.
x. Standby electric generator fuel tank level
xi. Standby electric generator failure alarm
xii. Flow meter valve vault door not fully closed light ZL-41.1

END OF SECTION
SECTION 16700
SCADA SYSTEM

PART 1 GENERAL

1.1 SUMMARY – A SCADA system shall be provided as part of the ozone control system. The SCADA system shall monitor and remotely control the ozone production system, ozone water treatment system (ozone contact basin and related devices) and the Lake Diversion pump controls as described in specification 11200 from an operator interface to be located in the biologist office. The SCADA system shall also monitor the standby electrical generator and ATS status.

1.2 SYSTEM DESCRIPTION - The SCADA system shall provide one operator interface in the biologist office. It shall provide radio telemetry at the biologist office, at the ozone equipment building and at the Lake Diversion pump control panel. It shall be fully coordinated with the ozone system controls being provided under specification 11200. Communication between the ozone control panel and the SCADA system shall be Modbus TCP. The SCADA system shall provide a CTU (central terminal unit) at the biologist office for connection of future instrumentation and controls. Radios shall be spread spectrum. Instrumentation outside the ozone production building but not at the Lake Diversion pump control panel shall be hard wired to the ozone system PLC inside the ozone production building. The CTU at the biologist’s office shall include an autodialer feature.

1.3 PERFORMANCE REQUIREMENTS

A. Radio telemetry shall include a 20 dB fade margin.

B. The SCADA system shall provide an operator friendly environment; multiple level password protected security; color graphics; historical logs of recorded data; manual and automatic recording modes; alarm annunciation; time stamped alarm logging; intuitive displays, reports and logs; on-line operator modification of controller parameters, on-line operator modification of the SCADA system data base including additions and deletions; operator adjustable scaling of inputs and outputs; operator adjustable trip points for alarms and interlocks; automatic data backup and archived; and on-line documentation of the system. A fully operational SCADA system shall be provided to the complete satisfaction of the ENGINEER and OWNER including the creation of: the I/O database; calculated values; interlocks, sequencers, graphic displays, daily and monthly water productions reports.

C. The mean time to repair SCADA system hardware at the board level shall not exceed 15 minutes.

D. SCADA system tag names shall follow the tag names defined in the P&I Diagrams for this project.
E. The SCADA system shall not connect to the internet or any other offsite entity or device.

F. The autodialer feature at the biologist’s office CTU shall provide alarms to ozone system operators when they are not stationed at the hatchery. The autodialer shall call a first responder telephone number. If the first responder does not acknowledge the alarm, then the autodialer shall proceed to a second responder telephone number and up to four telephone numbers until an alarm is acknowledged. The operator shall be able to adjust the time during which calls are to be made and the telephone numbers of each level of responder. An existing dial-up telephone (voice line) shall be used by the autodialer.

1.4 SUBMITTALS

A. FOR INFORMATION
   1. Elementary diagrams showing internal wiring of manufactured devices and assemblies.
   2. Point to point wiring diagrams showing terminations and wire numbers for each assembly.
   3. Dimension prints for each device or assembly
   4. Installation manual for each device or assembly
   5. Dimensions of areas required for servicing device or assembly
   6. Nameplate data and ratings for all devices
   7. Recommended spare parts and special tools list for maintaining equipment in service for one year and five year periods
   8. Catalog literature for each device or assembly

B. FOR REVIEW & APPROVAL
   1. Review shall not remove responsibility for furnishing material or devices of acceptable dimensions, quantity, quality, or errors thereof.
   2. Drawings not clearly marked or lacking the contractor’s approval stamp shall be rejected.
   3. Elementary (loop) diagrams showing schematically each device in a loop or control scheme, when not furnished with the ISSUED FOR CONSTRUCTION drawings.
   4. Panel layouts with bills of material.
   5. Functional description of interlocks and control systems
   6. PLC/SCADA interlock ladder-logic diagram or program listing

C. FOR RECORD
   1. Operation and maintenance manuals shall be delivered six weeks prior to project completion for each device or assembly.
   2. Markup deviations to ISSUED FOR CONSTRUCTION drawings with red pencil and provide original to ENGINEER for record.
1.4 QUALITY ASSURANCE
1.4.1 Control System Integrator (CSI) Qualifications

The CSI shall be the ozone production system manufacturer.

1.5 WARRANTY – Not used

1.6 OWNER’S INSTRUCTIONS

A. On-site instruction of owner’s operating personnel for 16 hours at the job site shall be provided at the conclusion of final checkout and startup. Instruction shall include proper operation and maintenance of instrumentation.

B. Operator training shall include: a general description of the system, a rough overview of the computer hardware, how to navigate the screens, explanation of the variables on each screen, how to start up the system, all feature of normal operation, alarm and fault resolution, and shutdown of the system.

C. Maintenance training shall include: a detailed description of the hardware including communications devices, navigation of the maintenance screens (diagnostic screens), operation of loops, utility software, backup and recovery of the system, periodic and preventative maintenance procedures, and review of vendor manuals.

1.7 COMMISSIONING

A. A site acceptance test shall be provided in which all functions of the SCADA system shall be demonstrated to operate satisfactorily. This test shall include:
   - Input / output (loop) checks from each field device
   - Testing of each mode of operation
   - Testing of functional units of programming (automatic, interlocks, and sequences.)
   - Testing of power loss and restoration.
   - Testing of communication loss and restoration.

1.8 MAINTENANCE

A proposal for post project support of the SCADA system shall be provided. This proposal shall include phone consultation rates; modem trouble-shooting rates, and on-site personnel rates.
1.9 SPARE PARTS

The following spare parts shall be provided.

- Four of each type and size of fuse.
- Four of each type and size of indicating lamps.
- One of each type of PLC chassis card.
- One of each type of radio.

PART 2 PRODUCTS

2.1 MANUFACTURERS

PLC's shall be Allen Bradley, which is Texas Parks and Wildlife's standard.

The biologist office HMI/work station shall use Wonderware, which is Texas Parks and Wildlife's standard.

2.2 EXISTING PRODUCTS – Not used

2.3 MANUFACTURED UNITS – Not used

2.4 COMPONENTS

A. The ozone production system PLC shall have 20% spare slot capacity for
digital inputs, digital outputs, analog inputs, analog outputs and
communication ports.

C. All PLC inputs and outputs shall be wired through terminal blocks, which
shall provide fusing, and LED indication of I/O status.

D. All PLC programming shall be done using ladder logic.

E. All PLC’s and PC’s shall be provided with Ethernet networking cards.

F. All licenses including the development system shall be the property of the
owner.

G. All digital outputs shall be dry contact form C relay with 120 vac and 5
amp ratings.

H. All digital inputs shall accept dry contacts and operate at 24v dc.

I. All analog inputs shall be either 4-20 mA or 100 ohm platinum RTD.

J. All 4-20mA analog inputs shall provide 12-bit accuracy minimum A/D
conversion.
K. All 4-20mA analog outputs shall provide 12-bit accuracy minimum D/A conversion.

L. The SCADA system shall support wwf, clp, bmp, tif, gif, pcx, dxf, jpg, and Autocad formats for insertion into displays and animation of vector based objects.

M. The SCADA system shall provide an extensive library of complex graphic objects.

N. The SCADA system shall provide base editing of objects that will update all displays using that object without the need to change each display.

O. Not used

P. The SCADA system shall be capable of developing custom objects.

Q. The SCADA system shall provide activity logging, alarm logging, and data logging, which can be downloaded to Microsoft’s Access or other OSBC compliant database.

R. Not used.

S. The SCADA system shall provide on-line editing of graphics.

T. The SCADA system shall announce alarms, simple reports, through pagers, faxes, e-mail, telephones, cell phones, or audibly and when needed on a scheduled basis.

U. A self-supporting and fully hot dip galvanized steel tower designed and installed in accordance with ANSI, NFPA, and EIA standards for each required tower’s intended location shall be provided with antenna, antenna mount, coax, warning signs, anti-climb section, and lightning protection.

V. Each required tower shall include the foundation, grading, grounding, lightning rod, antenna discharge unit, and superstructure. The foundation shall be designed and sealed by a Texas registered professional engineer.

W. Each required tower shall be installed by qualified personnel. Installer shall have a minimum of three years experience installing this type of tower.

X. Height adjustments to the tower and/or the antenna shall be made to insure communication. All height adjustments for proper communication shall be made with no additional costs to the Owner. The tower shall be warranted for a period of not less than 5 years.

Y. A non-transferable, non-exclusive right and license to use and modify the developed application software shall be provided to the owner.
2.5 ACCESSORIES – Not used

2.6 FABRICATION – Not used

PART 3 EXECUTION

3.1 INTERFACE WITH OTHER WORK

Coordinate with electrical, mechanical, and equipment installation schedules and other construction activities as needed to progress the project.

3.2 INSTALLATION – Not used

END OF SECTION