Technical Specifications
Specification Number: 75% Submittal
Project Name: NERT L09 Weir Dewatering Treatment

Nevada Environmental Response Trust Site
Henderson, Nevada

PREPARED ON BEHALF OF

Nevada Environmental Response Trust
35 E. Wacker Drive, Suite 1550
Chicago, IL 60601

PREPARED BY

Tetra Tech, Inc.
1489 West Warm Springs Road, Suite 110
Henderson, NV 89014

February 15, 2017

SPECIFICATION REVISION INDEX

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			Prepared By	Reviewed By	Project Engineer	Project Manager	Client
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Technical Specifications
Specification Number: 02200
Project Name: NERT L09 Weir Dewatering Treatment

Nevada Environmental Response Trust Site
Henderson, Nevada

PREPARED ON BEHALF OF

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February 15, 2017

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Report of Geotechnical Investigation, Weir Dewatering Treatment, Pump Stations, Nevada Environmental Response Trust, Henderson, Nevada, Tetra Tech, February 14, 2017.

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TETRA TECH	**Summary of Work** **Technical Specification**	**SPECIFICATION NUMBER: 01010** **PROJECT NUMBER: 117-7502016-L09** **PROJECT NAME: Weir Dewatering Treatment**

SPECIFICATION REVISION INDEX

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SECTION 01010

SUMMARY OF WORK

Note 1: Attachments and referenced Technical Specifications (Division 1 through Division 16 Sections) listed in this Technical Specification Section 00005 Table of Contents constitute the scope of work and responsibilities of the General Contractor. Technical Specification Sections that are referenced but not included in this Table of Contents are not applicable to this Sub Contract.

PART 1 GENERAL

1.1 PROJECT SUMMARY

A. The Southern Nevada Water Authority (SNWA) is in the process of constructing weirs along the Las Vegas Wash to mitigate erosion. Two weirs, the Sunrise Mountain Weir and the Historic Lateral Weir, are proposed for construction in the vicinity of where the perchlorate groundwater plume from the NERT Site intersects the Las Vegas Wash. Construction of these weirs is anticipated to begin in June 2017 and conclude in 2019. During the weir construction activities, groundwater which is contaminated with perchlorate will be generated. The groundwater must be treated for perchlorate removal before it is returned to the Wash downstream of the construction activities. The Weir Dewatering Treatment Project will consist of the design and construction of a system to pump and treat groundwater generated from the weir construction sites.

1.2 RELATED SECTIONS

A. Section 01320 – Construction Progress Documentation

B. Section 01500 – Construction Facilities and Temporary Controls

C. Section 01700 – Contract Closeout

D. Section 01720 – Project Record Documents

E. Drawing G-004 – Site Parking, Staging and Storage Area

1.3 OVERALL PROJECT DESCRIPTION

A. The Weir Dewatering Treatment project is designed for perchlorate removal from groundwater generated from the dewatering operations. Groundwater from the Sunrise Mountain weir and Historic Lateral weir construction sites is pumped by others to pump stations, designated as the Sunrise Mountain Pump Station (SMPS) and the Historic Lateral Pump Station (HLPS). The groundwater is then pumped from each pump station

to the Central Water Treatment Plant (CWTP). The SMPS and CWTP will be placed on one site, next to the existing pump station on the Basic Environmental property easement, and the HLPS will be on a separate site. The CWTP consists of cyclones which are design to remove large solid particles with a specific gravity equal to or large than 2.0. Following the cyclones, groundwater flows to multi-media filters where solids particles equal to or large than 10 microns are removed. Follow the multi-media filters, the groundwater is treated by ion exchange for perchlorate removal. The treated water is then discharged into the Las Vegas Wash.

B. The CWTP/SMPS and HLPS sites are surrounded by earthen berms covered with a HDPE geomembrane liner and filled with graded aggregate base, to provide secondary containment. The containment volume will have a minimum containment volume of 110% of the volume of the largest tank located inside the respectively containment area.

C. Yard piping for the project includes:
   1. 18" underground carbon steel pipes conveying water from the HLPS site will be conveyed to the CWTP/SMPS site.
      18" underground carbon steel pipe conveying treated water from the CWTP/SMPS will be conveyed to the Las Vegas Wash.

1.4 BID SOLICITATION

A. Tetra Tech, Inc. has pre-qualified General Contractors to bid on the Weir Dewatering Project's package for the installation of pump and process equipment; construction of concrete foundations, equipment pads, pipe supports; installation of process and yard piping; and electrical/instrumentation construction; and testing per the project drawings and specifications. It is expected that the Suppliers will furnish all bulk materials required for the scope of work. Tetra Tech, Inc. is seeking competitive bids for the scope of work described below.

B. Bidders are requested to review below scopes of work.

C. The drawings and specifications accompanying this bid request are complete for material takeoff and bidding.

1.5 WORK COVERED BY CONTRACT DOCUMENTS

A. Bid Schedule:
   1. All Work in connection with, including but not limited to:
      a. Installation of the Process Equipment inside the SMPS, HLPS and CWTP sites, including: Centrifugal and Progressing Cavity Pumps; Cyclone System; Multi-Media Filter System; Ion Exchange System; Baker Tanks; Generators; Instruments; and Electrical and Control Panels; including all supports, anchors and accessories;
      b. Construction of earthen berms and placement of fill above HDPE liner at the SMPS, HLPS and CWTP sites;
      c. Installation of HDPE geomembrane liner systems for secondary containment at the SMPS, HLPS and CWTP sites;
      d. Construction of reinforced concrete foundations for all Process Equipment, including attachments of liner to edges of foundations;
      e. All process piping at the SMPS, HLPS and CWTP sites, including valves, fittings, supports and accessories;
      f. All yard piping as described in Section 1.3C;
      g. All electrical, instrumentation and control installation; and,
      h. Miscellaneous materials, labor, equipment, valves, piping, fittings, and appurtenances in accordance with the Contract, as shown on the drawings and specified herein, as required for a complete and fully functional installation.

B. Furnish all materials, equipment, supplies, painting, appurtenances; provide all construction equipment and tools; and perform all necessary labor and supervision for the above.

C. Construct the Work under lump sum contracts as indicated in the Bid.

D. It is the intent of this Contract that Work proceed in the most expeditious manner possible.

1.6 REGULATORY REQUIREMENTS

A. General Contractor shall acquire all licenses required by the State of Nevada necessary to perform the Work as identified in specific scopes of Work of the Contract Documents.

B. Comply with all other federal, state, and local laws, regulations, codes, and ordinances applicable to the Work.

C. References in the Contract Documents to local codes shall mean the codes in effect in Henderson, Nevada.

D. Other standards and codes which apply to the Work are designated in the specifications.

E. Other Health and Safety Requirements are included in Section 1.15 of this Specification.

1.7 WORK BY OTHERS

A. All survey and geotechnical investigations will be done by others.

B. Procurement of Process Equipment, including: Centrifugal and Progressing Cavity Pumps; Cyclone System; Multi-Media Filter System; Ion Exchange System; Baker Tanks; Generators; Instruments; and Electrical and Control Panels.

C. Setting of Ion Exchange System Equipment.

D. Resin change-outs for Ion Exchange System.

E. Permits and Associated Permit Fees:

1. Dust control permit for construction activities including surface grading and trenching.

2. Clark County Building Department Grading Permit.

3. Clark County Building Department Structural Permit.

4. Clark County Building Department Electrical Permit.

F. Contingency and work plan requirements.

1.8 COORDINATION

A. Provide utility notification and coordination so that access is available for deliveries and construction and so Engineer is aware of work schedule.

B. Work hours are 7:00am to 5:00pm. Coordinate all work including site access and receipt of materials with Kyle Hansen, the site coordinator. Contact Kyle Hansen at 801-949-6663.

C. Coordinate the progress of the Work including coordination between trades, other Sub-Contractors, and Engineer to ensure timely progress of the Work.

D. Coordinate scheduling, submissions, and Work of the various Sections of specifications to provide efficient and orderly sequence of installation of interdependent construction elements with provisions for accommodating items installed later.

E. Coordinate completion and cleanup of Work of separate Sections of specifications in preparation for Substantial Completion including Startup and Commissioning.

F. Coordinate the completion of all Work in its entirety to ensure that all Contract Document requirements are met for a complete and operational water treatment facility.

1.9 GENERAL CONTRACTOR USE OF SITE AND PREMISES

A. Confine construction operations to the immediate vicinity of the location indicated on the Drawings and use due care in placing construction tools, equipment, excavated materials, and pipeline materials and supplies, so as to cause the least possible interference to adjacent areas and interference with other construction traffic and to avoid contaminated areas.

B. Company Property:
   1. If use of land outside Company's property is desirable or necessary, obtain consent of, and execute a written agreement with, the Company and tenant of adjacent property or land.
   2. Do not enter for material delivery or occupy for any purpose with personnel, tools, equipment, construction materials, or excavated materials, any property outside the designated construction area without written permission of the Engineer and Company.
   3. Do not enter for any reason contaminated areas as listed in the site safety plan.

C. Coordinate use of premises under direction of Engineer.

D. Assume full responsibility for the protection and safekeeping of Engineer pre-purchased and General Contractor purchased equipment, materials and/or products stored on site under this Contract.

E. Move any stored products, under General Contractor's control, which interfere with Company and Operations.

F. Laydown area is available as shown on Drawing G-004 – Site Parking, Staging and Storage Area.

G. No utilities are available at site for toilets, potable water, or power. Supplier is to make their own provisions for these.

1.10 PROTECTION OF PROPERTY

A. Protect, shore, brace, support, and maintain underground pipes, conduits, drains, and other underground construction uncovered or otherwise affected by construction operations. If existing utilities are discovered during construction that are not shown on the Drawings and do not meet minimal clearance requirements, notify Engineer to determine resolution. Document and map existing utilities per Section 01720.

B. Restore to their original condition, pavement, surfacing, driveways, walks, buildings, utility poles, guy wires, fences, and other surface structures affected by construction operations whether within or outside the easement or limits of construction

C. Use new materials for replacements

D. Do not remove trees outside the limits of construction, except as authorized by Engineer:
   1. Where practical, tunnel beneath trees in yards and parking areas when on or near the trench line
   2. Employ hand excavation as necessary protect tree injury
   3. Adequately protect trees left standing against damage by construction operations

E. General Contractor shall be responsible for all damage to roads, highways, shoulders, ditches, embankments, culverts, location or character, which may be caused by transporting equipment, materials, or personnel to or from the Work or any site thereof, whether by him or his Sub-Contractors.

F. Make satisfactory and acceptable arrangements with the Engineer of, and/or the agency or authority having jurisdiction over, any damaged property concerning its repair or replacement or payment of costs incurred in connection with the damage

G. Keep fire hydrants and water control valves free from obstruction and available for use at all times

1.11 CUTTING AND PATCHING

A. Cutting and patching of existing structures or for the replacement of defective Work shall comply with the following requirements.

B. Employ skilled and experienced personnel to perform cutting and patching.

C. Submit written request in advance of cutting or altering elements which affects:
   1. Structural integrity of element
   2. Integrity of weather-exposed or moisture-resistant elements
   3. Efficiency, maintenance, or safety of element
   4. Visual qualities of sight-exposed elements
   5. Work of Company or separate Sub-Contractor

D. Inspection:
   1. General Contractor shall be responsible for scheduling and coordinating pre- and post-inspections with Engineer
   2. Inspect existing conditions of the project, including elements subject to damage or to movement during cutting and patching
   3. After uncovering work, inspect the conditions affecting the installation of products, or performance of the work

4. Report unsatisfactory or questionable conditions to the Engineer in writing; do not proceed with the work until the Engineer has provided further instructions

E. Preparation:
   1. Provide adequate temporary support as necessary to assure the structural value and integrity of the affected portion of the Work
   2. Provide devices and methods to protect other portions of the project from damage
   3. Provide protection from the elements for that portion of the project which may be exposed by cutting and patching work, and maintain excavations free from water and other debris
   4. Execute fitting and adjustment of products to provide a finished installation to comply with specified products, functions, tolerances and finishes
   5. Restore work which has been cut or removed; install new products to provide completed Work in accordance with requirements of Contract Documents
   6. Fit work airtight to pipes, sleeves, ducts, conduit and other penetrations through surfaces

F. Execution: Execute cutting, fitting, and patching including attendant excavation and backfill, required to complete Work, or to:
   1. Fit the several parts together, to integrate with other Work
   2. Uncover portions of the Work to install or correct ill-timed Work
   3. Remove and replace defective and non-conforming Work
   4. Remove samples of installed Work as specified for testing
   5. Provide openings in elements of Work for penetrations of mechanical and electrical Work

G. Execute work by methods which will avoid damage to other Work, and provide proper surfaces to receive patching and finishing.

H. Cut rigid materials using concrete saw or core drill.

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

J. Identify any hazardous substance or condition exposed during the Work to the Engineer for decision or resolution.

1.12 MAINTENANCE OF TRAFFIC

A. Reference Section 01500 for traffic control requirements

B. Conduct Work to interfere as little as possible with site traffic, whether vehicular or pedestrian:

1. Whenever it is necessary to cross, close, or obstruct access roads and walks, provide and maintain suitable and safe bridges, detours, or other temporary expedients for accommodation of traffic

2. In making site or access road crossing, maintain 24-30 foot wide access of the impacted road at all times:
    a. Whenever possible, widen the shoulder on the opposite side to facilitate traffic flow.
    b. Provide temporary surfacing on shoulders as necessary.

C. Detour:
1. Provide, as required, bridges across trenches, barricades, guardrail approaches, lights, signals, signs, and other devices necessary for protection of the Work and personnel safety
2. Where the Contract requires that traffic be maintained over any construction work on site and traffic cannot be maintained on the original roadbed, or access, construct and maintain a detour around the Work.

1.13 BARRICADES AND LIGHTS

A. Provide barricades and lights under provisions of Section 01500

1.14 FIELD SURVEYING

A. Provide field surveying to establish the lines and grade and construction control need to install the pump stations and treatment plant.

1.15 SAFETY

A. General Contractor shall review and comply with Tetra Tech Health and Safety Plan (HASP). General Contractor shall review the HASP and return signature forms for all personnel who will be on site prior to mobilization. Tetra Tech will provide hazard communication training on potential site hazards to Supplier.

B. Kyle Hansen is the site safety representative.

C. General Contractor is to provide their own Safety Plan for this work. A Job Safety Analysis (JSA) must be completed in accordance with this plan and the Tetra Tech HASP, and reviewed by the Tetra Tech program health and safety director. The JSA must include, but is not limited to, the hazards associated with contaminated soils, and water.

D. Supplier is responsible for all PPE.

1.16 SPECIAL INSTRUCTIONS

A. A kickoff meeting at the site is to be held at mobilization and will included Health and Safety requirements and hazard communications training.

B. Work may be around contaminated soils and water. This will be explained in more detail as part of the hazard communication training. Personal protective equipment such as face shields, rubber over-boots, and chemical-resistant gloves may be required to prevent dermal contact with contaminated materials.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

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SECTION 01011

PERMITS AND AGREEMENTS

PART 1 GENERAL

1.01 GENERAL REQUIREMENTS:

A. The Engineer shall obtain and pay for any and all permits and licenses required for this project, except as otherwise provided herein and in effect at the time of bidding.

B. The General Contractor shall schedule all inspections and obtain all written approvals of the agencies required by the permits and licenses.

C. The General Contractor shall comply with all construction-related conditions specified in each of the permits, encroachment agreements, easement agreements, and licenses obtained by the Engineer.

D. Copies of the permits, encroachment agreements, and applicable easement agreements obtained by the Engineer are attached at the end of this Section.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 PERMIT AND AGREEMENT CONDITIONS:

A. The Engineer shall honor the letter and the spirit of the respective permits, encroachment agreements, and easement agreements in addition to the Drawings and Specifications.

B. Nothing in said permits, encroachment agreements, and easement agreements shall serve to decrease or negate the requirements of the Contract Documents.

3.02 STORMWATER POLLUTION PREVENTION PLAN:

A. All land-disturbing activities associated with this project are subject to the requirements of the approved Stormwater Pollution Prevention Plan (SWPPP) and NPDES General Permit.

B. Environmental protection requirements associated with the SWPPP are described in Section 01500.

C. If General Contractor elects to secure staging and stockpile areas within the project site, General Contractor shall install temporary sediment control devices around all such areas in accordance with the sedimentation and erosion control specifications for the State of Nevada.

D. The General Contractor shall be responsible for completing all monitoring and preparing all inspections reports to be submitted to the Nevada Department of Environmental Protection

(NDEP) / EPA. The General Contractor shall be responsible for maintaining a copy of the approved SWPPP on the construction site at all times. The General Contractor shall display the sediment and erosion control approval certificate on the construction site at all times.

E. Erosion control devices (silt fence, sediment tubes, construction entrances, etc.) will be installed as specified and in accordance with the requirements of the approved SWPPP and NPDES General Permit. Where a device must be placed before construction, removed during construction and replaced following construction, no extra payment will be made for the removal and replacement operations. At a minimum, devices will be installed as shown on the Drawings. Additional devices may be installed by the General Contractor, if so directed by the Engineer.

3.05 PERMITS, AGREEMENTS, AND APPROVALS:

A. The Engineer is responsible for obtaining and paying for the following permits, agreements, and approvals:

1. Stormwater Pollution Prevention Plan (SWPPP) approved by the NDEP

2. General Permit for Storm Water Discharge associated with Construction Activity (NOI and NOT)

3. Building Permits (Grading, Structural and Electrical) approved by Clark County

END OF SECTION

(PERMITS AND AGREEMENTS FOLLOW THIS SECTION)

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SECTION 01030

APPLICATIONS FOR PAYMENT

PART 1 GENERAL

1.01 GENERAL REQUIREMENTS:

A. Submit Applications for Payment to the Engineer in accordance with the schedule established by Conditions of the Contract and Agreement between Engineer and General Contractor.

1.02 RELATED REQUIREMENTS:

A. Section 01160: Change Order Procedures.

B. Section 01270: Measurement and Payment.

C. Section 01700: Contract Closeout.

D. Section 01720: Project Record Documents.

1.03 FORMAT AND DATA REQUIRED:

A. Provide Application for Payment Form to Engineer for review and approval prior to submitting the first application.

B. Submit applications typed on forms as approved by the Engineer.

C. Provide itemized data typed on $8^{½}$ x 11-inch white paper continuation sheets.

1.04 PREPARATION OF APPLICATION FOR EACH PROGRESS PAYMENT:

A. Application Form:

1. Fill in required information, including that for Change Orders executed prior to date of submittal of application.

2. Fill in summary of dollar values to agree with respective totals indicated on continuation sheets.

3. Execute certification with signature of a responsible officer of Contract firm. An original signature shall appear on each copy submitted.

B. Continuation Sheets:

1. Fill in total list of all scheduled component items of Work with item number and scheduled dollar value for each item.

2. Fill in dollar value in each column for each scheduled line item when work has been performed or products stored. Round off values to nearest dollar, or as specified for Measurement and Payment.

3. List each Change Order executed prior to date of submission at the end of the continuation sheets. List by Change Order Number and description as for an original component item of work.

4. To receive approval for payment on component material stored on-site, submit certified true copies of the original invoices with the application for payment first made for these materials. Copies of paid invoices must be submitted for all materials stored longer than 60 days to continue to receive approval for payment on the materials. If paid invoices are not submitted for materials in storage longer than 60 days, those materials shall not be considered in the Application for Payment.

1.05 SUBSTANTIATING DATA FOR PROGRESS PAYMENTS:

A. When requested, submit suitable substantiating information, with a cover letter identifying:

1. Project.

2. Application number and date.

3. Detailed list of enclosures.

4. For stored products:

a. Item number and identification as shown on application.

b. Description of specific material.

B. Submit one (1) electronic copy of data and cover letter for each copy of application.

C. As a prerequisite for payment, submit a Surety Acknowledgment of Payment Request letter showing amount of progress payment being requested.

D. Maintain an updated set of drawings to be used as Record Drawings in accordance with Section 01720. As a prerequisite for monthly progress payments, exhibit the updated Record Drawings for review by Engineer.

E. As a prerequisite for payment, submit the updated construction schedule in accordance with Section 01321. If the General Contractor fails to submit the required updated schedule within the time prescribed, the Engineer may withhold approval of progress payment estimates until such time as the General Contractor submits the required updated schedule. Submit one (1) electronic copy for each copy of the application.

F. As a prerequisite for payment, submit an accumulating cost curve (tabular and diagram) indicating schedule, forecast, and actual progress. Submit one (1) electronic copy for each payment application.

G. The General Contractor shall demonstrate to the Engineer, as a prerequisite for monthly progress payments, compliance with all requirements specified in Item 1.07 in Section 01500. If the General Contractor fails to demonstrate compliance with Item 1.07 in Section 01500, the Engineer may withhold approval of progress payment estimates until such time as the General Contractor demonstrates to the Engineer full compliance with the approved erosion and sedimentation control plan and Item 1.07 in Section 01500.

1.06 PREPARATION OF APPLICATION FOR FINAL PAYMENT:

A. Fill in Application form as specified for progress payments.

B. Use continuation sheet for presenting the final statement of accounting as specified in Section 01700 – Contract Closeout.

C. Submit all Project Record Documents in accordance with Sections 01050 and 01720.

1.07 SUBMITTAL PROCEDURE:

A. Submit Applications for Payment to the Engineer at the times stipulated in the Agreement.

B. Submit one (1) electronic copy of each Application.

D. When Application is found to be properly completed and correct, one (1) electronic copy will be returned to Engineer and General Contractor.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

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SECTION 01040

COORDINATION

PART 1 GENERAL

1.01 OPERATION OF EXISTING FACILITIES AND SHUTDOWNS:

A. Work under this Contract shall not unduly interfere with the operation of the existing facilities.

B. Work under this Contract shall be executed in such fashion that the existing facilities may be kept in continuous operation or readiness except for limited scheduled shutdowns.

C. Shutdowns of the existing facilities will be arranged at the convenience of the Engineer. No shutdowns shall be commenced without specific permission of the Engineer. The Engineer shall be notified at least ten (10) workdays prior to shutdowns.

D. The Engineer reserves the right to cancel scheduled shutdowns if conditions warrant. Delays to the General Contractor caused by cancellations will be considered in evaluating requests for time extensions.

E. Perform all construction necessary to complete connections and tie-ins to existing facilities.

F. Keep existing facilities in operation unless otherwise specifically permitted in these Specifications or approved by the Engineer.

G. General Contractor shall perform all construction activities so as to avoid interference with operations of the facility and the works of others.

H. General Contractor shall not disrupt traffic flow related to deliveries or sludge removal to/from the site or shall make suitable arrangements in advance with the Engineer to coordinate the traffic flow when disruptions to the traffic flow are unavoidable.

I. The following is a list showing the extent of the shutdowns that will be permitted. It shall be used as a guide to prepare the required construction schedule. The following list is not necessarily complete:

1. General:

a. Shutdown periods are indicated in 24-hour calendar days, or number of hours.

b. Simultaneous shutdowns of more than one facility, except as specifically indicated, will not be permitted.

c. The General Contractor shall submit a plan consisting of a construction sequence, time schedule, and details of labor, equipment and material available for work to be performed during each shut down to the Engineer for approval. The plan shall demonstrate the General Contractor's ability to meet the time limitations.

d. All equipment and supplies required to complete the work during each shutdown period shall be on site before any facilities are taken out of service.

e. Operation of all existing valves and gates required for completion of the work shall be performed by the Engineer.

f. Insofar as possible, all equipment to be incorporated into existing facilities, shall be ready for operation before the existing facilities are shut down.

g. If the work intended to be done during shutdown periods is not done satisfactorily, or as planned, or within the time required or approved by the Engineer, the Engineer may order the General Contractor to work a 24-hour, seven day work week schedule with a full crew, or he may order the General Contractor to place the facility back in service and reschedule the shutdown, or he may order the work required to place the facility back in service to be done with other forces. If the work is done by other forces, the Engineer's costs will be deducted from the amounts due to the General Contractor. In no case shall the Engineer be required to make additional payments for overtime work or redoing the work due to the General Contractor's failure to complete the work in the allotted time.

h. The list of work required to be performed during and prior to the specific shutdown period may not be complete. The General Contractor shall schedule all work requiring a shutdown of a specific facility to be done during the scheduled shutdown period.

1.02 GENERAL CONTRACTOR COORDINATION:

A. Coordinate scheduling, submittals, and Work of the various Specifications sections to assure efficient and orderly sequence of installation of interdependent construction elements.

B. Verify that utility requirement characteristics of operating equipment are compatible with existing or planned utilities. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.

C. Coordinate space requirements and installation of mechanical and electrical work which are indicated diagrammatically on the Contract Drawings. Follow routing shown for pipes, ducts, and conduit, as closely as practicable; place runs parallel with line of building as applicable. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.

D. Conceal pipes, ducts, and wiring within the construction in finished areas, except as otherwise indicated. Coordinate locations of fixtures and outlets with finish elements.

E. Coordinate completion and clean-up of Work for Substantial Completion and for portions of Work designated for partial occupancy by the Engineer.

F. Coordinate access to site for correction of nonconforming work to minimize disruption of Engineer activities where the Engineer is in partial occupancy.

1.03 SEQUENCING OF WORK:

A. Construction activities shall be coordinated with the following additional construction work packages being performed by others.

1. CWP-03: Setting of Ion Exchange System Equipment and Resin Change-outs by Ion Exchange System Supplier.

B. The following equipment items will be furnished be Tetra Tech and delivered to the site on or before the dates indicated below. Tetra Tech will coordinate and confirm the actual delivery schedule with the General Contractor at least one (1) week prior to the expected delivery date. Tetra Tech will be responsible for all shipping and delivery charges. Upon delivery to the site, the General Contractor will be responsible for unloading and storage of the equipment items prior to installation by the General Contractor.

1. PWP-01 End-Suction Centrifugal Pumps: June 12, 2017

2. PWP-02 Cyclones: July 3, 2017

3. PWP-03 Multi-Media Filters: May 16, 2017

4. CWP-03 Ion Exchange System: May 12, 2017

5. PWP-04 Progressing-Cavity Pumps: April 14, 2017

6. PWP-08 Control Valves: June 5, 2017

7. PWP-11 Additional Centrifugal Pumps: June 12, 2017

C. Construction activities shall be phased as follows:

1. Shop Drawing Submittals: The following shall be submitted by the dates indicated below:

a. All shop drawing submittals required for the completion of the Construction Phase work activities as described below shall be submitted within two (2) calendar weeks of receiving written Notice of Award.

2. Construction Phase: Construction of Sunrise Mountain Pump Station/Central Water Treatment Plant and Historical Lateral Pump Station must be substantially complete **on or before July 25, 2017**.

3. Operational Start-up and Commissioning: Operational Start-up and Commissioning of the entire system (pump stations and treatment plant) must be substantially complete on or before **August 29, 2017**. The system shall be ready to receive and treat water by **September 5, 2017**.

D. General Contractor shall submit a detailed construction schedule in accordance with Section 01320 – Construction Progress Documentation clearly identifying the intended sequence of the Work and incorporating the sequencing listed above. Alternative work sequence proposals that achieve the stated objectives and coordination with the other work

packages may be considered after award. The Engineer reserves the right to refuse any and all alternative sequencing work plans.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION – NOT USED

END OF SECTION

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SECTION 01070

ABBREVIATIONS AND SYMBOLS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Abbreviations for organizations and standards

B. Other abbreviations and symbols

1.2 ORGANIZATIONS AND STANDARDS

AA	Aluminum Association
AAMA	Architectural Aluminum Manufacturers Association
AASHTO	American Association State Highway and Transportation Officials
ACI	American Concrete Institute
AFBMA	Antifriction Bearing Manufacturers Association
AGA	American Gas Association
AGMA	American Gear Manufacturers Association
AI	Asphalt Institute
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AMCA	Air Moving and Conditioning Association
ANSI	American National Standards Institute
APA	American Plywood Association
ASCE	American Society Civil Engineers
ASHRAE	American Society Heating, Refrigerating and Air Conditioning Engineers
ASME	American Society Mechanical Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society
AWPA	American Wood Products Association or American Wood Preservers Association
AWPB	American Wood Preserver's Board
AWWA	American Water Works Association
CDPHE	Colorado Department of Public Health and Environment
CDOT	Colorado Department of Transportation
CIPRI	Cast Iron Pipe Research Institute
CISPI	Cast Iron Soil Pipe Institute

CMAA	Crane Manufacturer’s Association of America
CRSI	Commercial Standard
FGMA	Flat Glass Marketing Association
FM	Factory Mutual
FS	Federal Specification
HMI	Hoist Manufacturer's Institute
IEEE	Institute Electrical and Electronics Engineers
IFI	Industrial Fasteners Institute
IPCEA	Insulated Power Cable Engineers Association
MIL	Military Specification
MMA	Monorail Manufacturer's Association
NAAMM	National Association Architectural Metals Manufacturers
NBHA	National Builders Hardware Association
NDOT	Nevada Department of Transportation
NEC	National Electric Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association or National Forest Products Association
NHPMA	Northern Hardwood and Pine Manufacturer's Association
NSF	National Sanitation Foundation Testing Laboratory
NWMA	National Woodwork Manufacturer's Association
OSHA	Occupational Safety and Health Administration
PCI	Prestressed Concrete Institute
PS	Product Standard
RCSHSB	Red Cedar Shingle and Hand-Split Shake Bureau
RIS	Redwood Inspection Service
SAE	Society of Automotive Engineers
SCPRF	Structural Clay Products Research Foundation
SJI	Steel Joist Institute
SPI	Society of the Plastics Industry
SSPC	Steel Structures Painting Council
TCA	Tile Council of America

UL	Underwriter's Laboratories
US	U.S. Bureau of Standards
USBR	U.S. Bureau of Reclamation
WCLIB	West Coast Lumber Inspection Bureau
WIC	Woodwork Institute of California
WWPA	Western Wood Products Association

1.3 OTHER ABBREVIATIONS AND SYMBOLS

ac	alternating current
amp	ampere
AV	air vent
AWG	American wire gage
BIL	basic impulse level
BCY	bank cubic yard
C	centigrade or Celsius
CIP	Complete-in-place
cu	cubic
dc	direct current
diam	diameter
F	Fahrenheit
ft (')	foot
ga	gage
gal	gallon
GSP	galvanized steel pipe
hp	horsepower
Hz	hertz
hrs(s)	hour(s)
IBBM	iron body, bronze mounted
in(")	inch
IPS	iron pipe size
kV	kilovolt
kVA	kilovoltampere

lb	pound
mA	milliampere
max	maximum
MG	million gallons
MH	manhole
NPT	national pipe thread
PL	plate
PVC	polyvinyl chloride
sq	square
lf	lineal foot
vf	vertical foot
yd	yard
°	degree
'	feet
"	inch
%	percent

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

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SECTION 01080

IDENTIFICATION SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Color coding, lettering, labeling and tagging of all new exposed pipe, designated beams, electrical equipment, and chemical storage tanks

1.2 RELATED SECTIONS

A. None

1.3 REFERENCES

A. ANSI 13.1—Scheme for the Identification of Piping Systems

PART 2 PRODUCTS

2.1 MATERIALS

A. Paint: As specified Section 09900

B. Metal Tags and Chains: Aluminum or stainless steel, stamped in identifying letters

C. Snap-On Markers: Plastic sleeves, Seton Name Plate “Setmark” or accepted substitution

D. Nameplates: Plastic, two colors for surface and core

E. Hazard warning signs: Aluminum NFR sign kit, as supplied by Lab Safety or accepted substitution

PART 3 EXECUTION

3.1 LOCATION OF IDENTIFICATION

A. Lettering and flow direction arrows:
   1. Near equipment served
   2. Close to valves or flanges
   3. Adjacent to branches, tees and changes in direction of pipeline
   4. At intervals of not more than 20 feet on straight runs, unless otherwise indicated by the Engineer.

3.2 LETTERING

A. Paint, stencil or use snap-on markers:

Letter Size As Follows:

Outside Diameter of Pipe or Covering (Inch)	Minimum Height of Letters (Inch)
5/8 or Smaller	Metal Tags—1/4
3/4 Through 4	3/4
5 or Larger	2

3.3 METAL TAGS

A. Provide on pipe 5/8 inch or smaller (including covering) outside diam

B. Color code as specified

3.4 SNAP-ON MARKERS

A. Increase length of pipe marker and letter height of marker wording with increase in pipe diameter, ANSI A13.1

B. Color code letters and background for high visibility according to the hazard level of pipe contents

3.5 NAMEPLATES

A. Provide nameplate on all electrically powered equipment and electrical enclosures:
   1. Size: Approximately 6 inch wide by 4 inch high, on red plastic surface engraved through to a yellow core
   2. Label: "Danger" in capital 1/2 inch letters on top line. The balance of sign in 3/8 inch capital letters reading: "Do not perform any equipment maintenance until main power disconnect is turned off and padlocked"
   3. Install in prominent location agreed to by Engineer.

B. Provide nameplate at all non-potable water outlets:
   1. Size: Approximately 3 inch wide by 2 inch high, on red plastic surface engraved through to a white core
   2. Label: "Non-Potable Water" top line and "Do Not Drink" second line in 1/2 inch capital letters
   3. Securely attach to wall, if possible or attach with stainless steel chain

C. Provide labels and hazard warning signs for all chemical storage tanks indicating type of chemical contained:
   1. Label: 8 inch capital letters, conform to Fire Code and NFPA 704 for size and color
   2. Sign: NFPA hazard warning, 18 inch by 18 inch, securely affixed to side of storage tank
   3. Securely bond to wall of each bulk storage tank so as to be conspicuously visible at all times

D. Provide nameplate at all potable water outlets:
   1. Size: Approximately 2 inch wide by 1-1/2 inch high, on white plastic surface engraved through to a red core
   2. Label: "Drinking Water" in 1/2 inch capital letters
   3. Securely attach to wall if possible or attach with stainless steel chain

3.6 SCHEDULED COLOR CODING

A. All 12-inch pipe and smaller shall be color coded per Section 3.8 of this Specification.

B. Bands where scheduled: 6-inch wide, at 5 foot intervals

C. Provide only bands of color on uninsulated stainless steel and PVC, elsewhere natural finish

3.7 PIPING NOT SCHEDULED

A. Paint to match wall or ceiling, unless otherwise directed by Engineer.

B. Appropriately identify and place flow arrows

C. Uninsulated stainless steel and PVC:
   1. Natural finish

3.8 SCHEDULE

A. Paint and letter colors:

Letters	Color of Pipe and Arrows	Color of Letters
Raw	Olive Green	Black
Potable water (hot, HPW or cold, PW),	Light blue	Black

Letters	Color of Pipe and Arrows	Color of Letters
Non-potable water (NPW), raw water (RW), or recycle water (RCW)	Medium purple	White
"Seal Water" (lines downstream from a backflow prevention unit or backflow (BPW)	Dark blue	White
Sample	Light gray with green bands	Black
Vent	Light gray	Black
Chlorine dioxide	Orange with black bands	Black
Chlorine (gas, liquid, or vent)	Yellow with Red Bands	Black
Backwash waste	Light Brown	White
Sludge or Reclaim	Dark Brown	White
Sewer (Sanitary or Other)	Dark Grey	White
Low pressure air (aeration supply)	Light green	Black
Compressed air	Dark Green	Black
Natural gas	Red	White
Other lines	Light Gray	Black
Drain	Light Grey	White
Non-potable Water (Downstream of Backflow Preventer)	Light blue	Black

B. Paint electrical conduit aluminum or match adjacent ceiling or wall surfaces as directed by Engineer.

C. Paint vent lines to match surfaces they adjoin

D. Specially paint the following items:

Item	Color
Valve handwheels and levers	Red
Hoist hooks and blocks	Yellow and Black stripes

END OF SECTION

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SECTION 01160

CHANGE ORDER PROCEDURES

PART 1 GENERAL

1.01 GENERAL REQUIREMENTS:

A. Promptly implement Change Order procedures.

1. Provide full written data required to evaluate changes.

2. Maintain detailed records of work done on a time-and-material/force account basis.

3. Provide full documentation to Engineer on request.

B. Designate in writing the member of General Contractor's organization:

1. Who is authorized to accept changes in the Work.

2. Who is responsible for informing others in the General Contractor's employ of the authorization of changes in the Work.

C. Engineer will designate in writing the person who is authorized to execute Change Orders.

1.02 RELATED REQUIREMENTS:

A. Section 01030: Applications for Payment.

B. Section 01320: Construction Progress Documentation.

C. Section 01630: Product Options and Substitutions.

D. Section 01720: Project Record Documents.

1.03 DEFINITIONS:

A. Change Order: See General Conditions.

B. Work Change Directive: A written order to the General Contractor, signed by Engineer, which amends the Contract Documents as described, and authorizes General Contractor to proceed with a change which affects the Contract Sum or the Contract Time, for inclusion in a subsequent Change Order.

C. Field Order: A written order to the General Contractor, signed by the Engineer and the General Contractor, which is issued to interpret/clarify the Contract Documents, order minor changes in the work and/or memorialize tradeoff agreements. The work described by a Field Order is to be accomplished without change to the Contract Sum, Contract Time, and/or claims for other costs.

1.04 PRELIMINARY PROCEDURES:

A. Engineer may initiate changes by submitting a Request for Proposal (RFP) to General Contractor. Request will include:

1. Detailed description of the change, products, and location of the change in the Project.

2. Supplementary or revised Drawings and Specifications.

3. The projected time span for making the change and a specific statement as to whether overtime work is or is not authorized.

4. A specific period of time during which the requested price will be considered valid.

5. Such request is for information only, and is not an instruction to execute the changes or to stop work in progress.

B. General Contractor may initiate changes by submitting a written notice to the Engineer containing:

1. Description of the proposed changes.

2. Statement of the reason for making the changes.

3. Statement of the effect on the Contract Price and the Contract Time.

4. Statement of the effect on the work of Engineers.

5. Documentation supporting any change in Contract Price or Contract Time, as appropriate.

C. No work requiring an increase in Contract Price is authorized until it is approved by Engineer in writing.

1.05 WORK CHANGE DIRECTIVE:

A. In lieu of a Request for Proposal (RFP), Engineer may issue a Work Change Directive for General Contractor to proceed with a change for subsequent inclusion in a Change Order.

B. The Work Change Directive will describe changes in the Work, both additions and deletions, with attachments of revised Contract Documents to define details of the change and will designate the method of determining any change in the Contract Price and any change in Contract Time.

C. Engineer will sign and date the Work Change Directive as authorization for the General Contractor to proceed with the changes.

D. General Contractor may sign and date the Work Change Directive to indicate agreement with the terms therein.

1.06 DOCUMENTATION OF PROPOSALS AND CLAIMS:

A. Support each quotation for a lump sum proposal and for each unit price which has not previously been established with sufficient substantiating data to allow Engineer to evaluate the quotation.

B. On request, provide additional data to support time and cost computations:

1. Labor required.

2. Equipment required.

3. Products required.

a. Recommended source of purchase and unit cost.

b. Quantities required.

4. Taxes, insurance, and bonds.

5. Credit for work deleted from Contract, similarly documented.

6. Overhead and profit.

7. Justification for any change in Contract Time.

C. Support each claim for additional costs, and for work done on a time-and-material/force account basis, with documentation as required for a lump sum proposal, plus additional information:

1. Name of the Engineer's authorized agent who ordered the work and date of the order.

2. Dates and times work was performed and by whom.

3. Time record, summary of hours worked, and hourly rates paid.

4. Receipts and invoices for:

   a. Equipment used, listing dates and times of use.

   b. Products used, listing quantities.

   c. Subcontracts.

D. Document requests for substitutions for Products as specified in Section 01630.

1.07 PREPARATION OF CHANGE ORDERS AND FIELD ORDERS:

A. Engineer will prepare each Change Order, Field Order, or Work Change Directive.

B. Change Order will describe changes in the Work, both additions and deletions, with attachments of revised Contract Documents to define details of the change.

C. Change Order will provide an accounting of the adjustment in the Contract Sum and in the Contract Time.

D. Field Order will describe interpretations or clarifications of Contract Documents, order minor changes in the Work, and/or memorialize trade-off agreements.

E. Field Order work will be accomplished without change in the Contract Sum, Contract Time, and/or claims for other costs.

1.08 LUMP SUM/FIXED-PRICE CHANGE ORDER:

A. Content of Change Orders will be based on, either:

1. Engineer's Proposal Request and General Contractor's responsive Proposal as mutually agreed between Engineer and General Contractor.

2. General Contractor's Proposal for a change, as recommended by Engineer.

B. Engineer will sign and date the Change Order as authorization for the General Contractor to proceed with the changes.

C. General Contractor will sign and date the Change Order to indicate agreement with the terms therein.

1.09 UNIT PRICE CHANGE ORDER:

A. Content of Change Orders will be based on:

1. Engineer's definition of the scope of the required changes;

2. General Contractor's Proposal for a change, as recommended by Engineer; or

3. Survey of completed work.

B. The amounts of the unit prices to be:

1. Those stated in the Agreement.

2. Those mutually agreed upon between Engineer and General Contractor.

C. When quantities of each of the items affected by the Change Order can be determined prior to start of the Work:

1. Engineer will sign and date the Change Order as authorization for General Contractor to proceed with the changes.

2. General Contractor will sign and date the Change Order to indicate agreement with the terms therein.

D. When quantities of the items cannot be determined prior to start of the work:

1. Engineer will issue a Construction Change Authorization directing General Contractor to proceed with the change on the basis of unit prices and will cite the applicable unit prices.

2. At completion of the change, Engineer will determine the cost of such work based on the unit prices and quantities used. General Contractor shall submit documentation to establish the number of units of each item and any claims for a change in Contract Time.

3. Engineer will sign and date the Change Order to establish the change in Contract Sum and in Contract Time.

4. Engineer and General Contractor will sign and date the Change Order to indicate their agreement with the terms therein.

1.10 TIME AND MATERIAL/FORCE ACCOUNT CHANGE ORDER/WORK CHANGE DIRECTIVE:

A. Engineer will issue a Work Change Directive directing General Contractor to proceed with the changes.

B. At completion of the change, General Contractor shall submit itemized accounting and supporting data as provided in Paragraph 1.06 Documentation of Proposals and Claims of this Section.

C. Engineer shall determine the allowable cost of such work, as provided in General Conditions and Supplementary Conditions.

D. Engineer will sign and date the Change Order to establish the change in Contract Sum and in Contract Time.

E. Engineer and General Contractor will sign and date the Change Order to indicate their agreement therewith.

1.11 CORRELATION WITH GENERAL CONTRACTOR'S SUBMITTALS

A. Monthly update Schedule of Values and Applications for Payment forms to record each Change Order as a separate item of Work, and to record the adjusted Contract Sum.

B. Monthly update the Construction Schedule to reflect each change in Contract Time. Revise subschedules to show changes for other items of work affected by the changes.

C. Upon completion of work under a Change Order, enter pertinent changes in Record Documents.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

(CHANGE ORDER FORM FOLLOWS THIS SECTION)

Change Order No. _____

Date of Issuance: | Effective Date:

Engineer: | Engineer's Contract No.:

General Contractor: | General Contractor's Project No.:

Project: | Contract Name:

The Contract is modified as follows upon execution of this Change Order:

Description:

Attachment: [List documents supporting change]

CHANGE IN CONTRACT PRICE	**CHANGE IN CONTRACT TIMES** *[note changes in Milestones if applicable]*
Original Contract Price: $_____	Original Contract Times: Substantial Completion: _____ Ready for Final Payment: _____ days or dates
[Increase] [Decrease] from previously approved Change Orders No. ___ to No. ___: $_____	[Increase] [Decrease] from previously approved Change Orders No. ___ to No. ___: Substantial Completion: _____ Ready for Final Payment: _____ days
Contract Price prior to this Change Order: $_____	Contract Times prior to this Change Order: Substantial Completion: _____ Ready for Final Payment: _____ days or dates
[Increase] [Decrease] of this Change Order: $_____	[Increase] [Decrease] of this Change Order: Substantial Completion: _____ Ready for Final Payment: _____ days or dates
Contract Price incorporating this Change Order: $_____	Contract Times with all approved Change Orders: Substantial Completion: _____ Ready for Final Payment: _____ days or dates

RECOMMENDED:

By: _____

Engineer

Title: (Authorized signature)

Date: _____

ACCEPTED:

By: _____

Title: General Contractor (Authorized signature)

Date: _____

Approved by Funding Agency (if applicable)

By: _____

Title: _____

Date: _____

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SECTION 01200

PROJECT MEETINGS

PART 1 GENERAL

1.01 PRE-CONSTRUCTION CONFERENCE:

A. Date, Time and Location

1. Conference will be held after execution of the Contract and before construction is started at the site. Engineer will fix the date, time and location of the meeting.

B. Required Attendance

1. General Contractor and Sub-Contractors.
2. Engineer's representative(s).
3. Representatives of government agencies having any degree of control or responsibility, if available.

C. Engineer shall prepare agenda, preside at meeting, and prepare and distribute a transcript of proceedings to all parties.

D. Agenda will include, but will not necessarily be limited to, the following:

1. Contract items.
2. Designation of responsible personnel.
3. General Contractors.
4. Coordination with other Sub-Contractors.
5. Construction Schedule.
6. Processing of Shop Drawings and distribution of Submittals.
7. Processing of field decisions and Change Orders.
8. Requirements for copies of Contract Documents.
9. Insurance in force.
10. Processing and Schedule of Payments.
11. Use of premises.
12. General Contractor responsibility for safety and first aid procedures.
13. Security.
14. Housekeeping.
15. Field Offices.
16. Record Drawings.
17. Letter of Authorization to Proceed.

18. Any other project related items.

1.02 PROGRESS MEETINGS:

A. Date and Time

1. Regular monthly meetings or as designated by Engineer.

2. Other meetings are on call.

B. Place

1. General Contractor's field office or other pre-designated place.

C. Engineer shall prepare agenda and distribute 48 hours prior to meeting, preside at meetings, and prepare and distribute a transcript of proceedings to all parties.

D. General Contractor shall provide data required and be prepared to discuss all items on agenda.

E. Minimum Attendance

1. General Contractor and other Sub-Contractor's representatives present for each party shall be authorized to act on their behalf.

2. Engineer.

3. Engineer's representative(s).

F. Agenda: To include, but not necessarily be limited to the following:

1. Safety.

2. Revisions and/or Corrections to Previous Memorandum.

3. Unresolved Items.

4. Administrative Items.

5. Change Orders.

6. Shop Drawings.

7. Problems, Conflicts, Observations.

8. Coordination with Engineer, General Contractor and/or other Sub-Contractors.

a. Bypasses and/or Shutdowns.

b. Other.

9. Progress since Last Meeting.

10. Planned Progress for Next Meeting.

11. Other Business.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION – NOT USED

END OF SECTION

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SECTION 01270

MEASUREMENT AND PAYMENT

PART 1 GENERAL

1.01 DESCRIPTION OF WORK:

A. This Section defines the method that will be used to determine the quantities of Work performed or materials supplied and establish the basis upon which payment will be made for the Project.

1.02 ADMINISTRATIVE SUBMITTALS:

A. Schedule of Values: Submit schedule on General Contractor's standard form. (Refer to paragraph 1.05 of this Section and Section 01370 – Schedule of Values for additional requirements.)

B. Schedule of Estimated Progress Payments (Refer to paragraph 1.06 of this Section for additional requirements):

1. Submit with initially acceptable Schedule of Values.
2. Submit adjustments thereto with Application for Payment.

C. Application for Payment (Refer to Section 01030 – Applications for Payment)

D. Final Application for Payment (Refer to paragraph of 1.06 of Section 01030 – Applications for Payment)

1.03 RELATED WORK:

A. Section 01030 – Applications for Payment.

B. Section 01330 – Shop Drawings, Product Data and Samples

C. Section 01160 – Change Order Procedures

D. Section 01370 – Schedule of Values

1.04 PRICE

A. Required items of Work and incidentals necessary for the satisfactory completion of the Project shall be considered incidental to the specified Work required under this contract and shall be considered as included in the unit prices for the various proposal items. The General Contractor shall prepare his Proposal accordingly to allow for such items:

1. Not specifically listed in the Proposal.
2. Not specified in this section to be measured or to be included in one of the items listed in the Proposal.

3. To include General Contractor's overhead and profit.

B. Work includes the furnishing of all labor, materials, equipment, tools, and related items for performing all operations required to complete the Project satisfactorily in place, as specified by the Contract Documents.

1.05 SCHEDULE OF VALUES:

A. Prepare a separate Schedule of Values for each phase of Work under the Agreement. Submit the Schedule of Values in accordance with Section 01370 – Schedule of Values.

E. Use line items in the proposal as line items in the Schedule. Provide adequate detail to allow easy determination of the percentage of work completed for each item.

C. Lump Sum Work.

1. Reflect Schedule of Values format included in conformed Bid Form, specified allowances, alternates, and equipment selected by Engineer, as applicable.
2. List bonds and insurance premiums, mobilization, demobilization, facility startup, and contract closeout separately.
3. Separate product costs and installation costs. Break down by Division 2 through 17 for each of the Project facilities.
    a. Product costs include cost for product, delivery and unloading, royalties and patent fees, taxes, and other cost paid directly to the supplier or vendor.
    b. Installation costs include cost for the supervision, labor and supervision, labor and equipment for field fabrication, erection, installation, start-up, initial operation and General Contractor's overhead and profit.
4. Divide principal subcontract amounts into an adequate number of line items to allow determination of the percentage of work completed for each item. These line items may be used to establish the value of work to be added or deleted from the project.

D. An unbalanced or front-end loaded schedule will not be acceptable.

E. Summation of the complete Schedule of Values representing all Work shall equal the Contract Price.

1.06 SCHEDULE OF ESTIMATED PROGRESS PAYMENTS:

A. Show estimated payment requests throughout Contract Times aggregating initial Contract Price.

B. Base estimated progress payments on initially acceptable progress schedule. Adjust to reflect subsequent adjustments in progress schedule and Contract Price as reflected by modifications to the Contract Documents.

1.07 APPLICATION FOR PAYMENT:

A. Transmittal Summary Form: Attach one Summary Form with each detailed Application for Payment for each schedule and include Request for Payment of Materials and Equipment on Hand as applicable. Execute certification by authorized officer of General Contractor. Provide separate form for each schedule as applicable.

B. Preparation:

1. Round values to nearest dollar.

2. List each Change Order and Written Amendment executed prior to date of submission as separate line item. Totals to equal those shown on the Transmittal Summary Form for each schedule as applicable.

3. Submit Application for Payment, including a Transmittal Summary Form and detailed Application for Payment Form(s) for each schedule as applicable, a listing of materials on hand for each schedule as applicable and such supporting data as may be requested by Engineer.

C. Include accepted Schedule of Values for each schedule or portion of Work, the unit price breakdown for Work to be paid on unit price basis, a listing of Engineer-selected equipment if applicable, and allowances, as appropriate.

1.08 MEASUREMENT – GENERAL

A. Weighing, measuring, and metering devices used to measure quantity of materials for Work shall be suitable for purpose intended and conform to tolerances and specifications as specified in National Institute of Standards and Technology, Handbook 44.

B. Whenever pay quantities of material are determined by weight, the material shall be weighed on scales furnished by General Contractor and certified accurate by the state agency responsible. A weight or load slip shall be obtained from the weigh facility and delivered to the Engineer's representative at the point of delivery of the material.

C. If material is shipped by rail, the car weights will be accepted provided that actual weight of material only will be paid for and not minimum car weight used for assessing freight tariff, and provided further that car weights will not be acceptable for material to be passed through mixing plants.

D. Vehicles used to haul material being paid for by weight shall be weighed empty daily and at such additional times as required by Engineer. Each vehicle shall bear a plainly legible identification mark.

E. All materials that are specified for measurement by the cubic yard measured in the vehicle shall be hauled in vehicles of such type and size that the actual contents may be readily and accurately determined. Unless all vehicles are of uniform capacity, each vehicle must bear a plainly legible identification mark indicating its water level capacity. All vehicles shall be loaded to at least their water level capacity. Loads hauled in vehicles not meeting the above requirements or loads of a quantity less than the capacity of the

vehicle, measured after being leveled off as above provided, will be subject to rejection, and no compensation will be allowed for such material.

F. Where measurement of quantities depends on elevation of existing ground, elevations obtained during construction will be compared with those shown on Drawings. Variations of l foot or less will be ignored, and profiles shown on Drawings will be used for determining quantities. Quantities will be based on ground profiles shown.

G. Units of measure shown on the Schedule of Values shall be as follows unless specified otherwise.

Item	Method of Measurement
AC	Acre-Field Measure by Engineer
CY	Cubic Yard-Field Measure by Engineer within the limits specified or shown
CY-VM	Cubic Yard-Measured in the Vehicle by Volume
EA	Each-Field Count by Engineer
GAL	Gallon-Field Measure by Engineer
HR	Hour
LB	Pound(s)-Weight Measure by Scale
LF	Linear Foot-Field Measure by Engineer
LS	Lump Sum-Unit is one; no measurement will be made
MFBM	Thousand Foot Board Measure-Delivery Invoice
SF	Square Foot
SY	Square Yard
TON	Ton-Weight Measure by Scale (2,000 pounds)

1.09 PAYMENT:

A. General:

1. The date for General Contractor's submission of monthly Application for Payment shall be established at the Pre-Construction Conference.

B. Payment for all Work shown or specified in the Contract Documents is included in the Contract Price. No measurement or payment will be made for individual items.

1.10 NONPAYMENT FOR REJECTED OR UNUSED PRODUCTS:

A. Payment will not be made for following:

1. Loading, hauling, and disposing of rejected material.

2. Quantities of material wasted or disposed of in manner not called for under Contract Documents.

3. Rejected loads of material, including material rejected after it has been placed by reason of failure of General Contractor to conform to provisions of Contract Documents.

4. Material not unloaded from transporting vehicle.

5. Defective Work not accepted by Engineer.

6. Material remaining on hand after completion of Work.

1.11 PARTIAL PAYMENT FOR STORED MATERIALS AND EQUIPMENT:

A. Partial payment for stored materials and equipment shall be in accordance with the Specifications.

1.12 ALLOWANCES

A. It is understood that General Contractor shall include in the Contract Price all allowances so named in this Specification to be performed for such sums and by such persons or entities as may be acceptable to Engineer.

B. Cash Allowances

1. Engineer agrees that:

i. Cash allowances include the cost to General Contractor (less any applicable trade discounts) of materials and equipment required by the allowances to be delivered at the Site, and all applicable taxes; and,

ii. General Contractor's costs for unloading and handling, labor, installation, overhead, profit, and other expenses incurrent for the cash allowances shall be included in the Contract Price and not in the allowances. Any requests for additional payment on any of the foregoing is not valid.

C. Prior to final payment, the Engineer shall issue appropriate Change Order to reflect actual amounts due to General Contractor on account of Work covered by the allowances, and shall correspondingly adjust the Contract Price.

1.13 PRICE PROPOSAL ITEMS

A. General Contractor will complete the Work for the following listed Work items for the prices listed on the Price Proposal:

Item No. 1: Performance and Payment Bond

1. Description – Work item shall include costs to bond the Work for the Project in accordance with the Drawings and Specifications, complete in place.
2. Measurement - Measurement of Item No. 1 will be by lump sum.
3. Payment for Bonds will be paid on the initial request for payment. Receipts or other proof of payment for the full amount of compensation requested for "Performance and Payment Bonds" shall be provided to the Engineer with the request for payment.

Item No. 2: Builders Risk Insurance

1. Description – Work item shall include costs to insurance the Work for the Project in accordance with the Drawings and Specifications, complete in place.
2. Measurement - Measurement of Item No. 2 will be by lump sum.
3. Payment for Insurance will be paid on the initial request for payment. Receipts or other proof of payment for the full amount of compensation requested for "Builders Risk Insurance" shall be provided to the Engineer with the request for payment.

Item No. 3: Mobilization/Start-up Activities

1. Description – Work item shall include mobilization costs associated with the Project. This shall include furnishing all labor, materials, tools, equipment and incidentals required to mobilize for the Project in accordance with the Contract Documents, complete and working in place.
2. Measurement - Measurement of Item No. 3 will be by lump sum.
3. Payment shall be based on the percentage of work completed for each item listed in the approved Schedule of Values.

Item No. 4: Demobilization

1. Description – Work item shall demobilization costs associated with the Project. This shall include furnishing all labor, materials, tools, equipment and incidentals required to demobilize from the Project in accordance with the Contract Documents, complete in place.
2. Measurement - Measurement of Item No. 4 will be by lump sum.
3. Payment for demobilization will be made upon completion of all work under this contract and the after the General Contractor has demobilized from the Site.

***NEED TO UPDATE

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION – NOT USED

END OF SECTION

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SPECIFICATION REVISION INDEX

Revision No.	Revision Date	Issued for	Signatures				
			Prepared By	Reviewed By	Project Engineer	Project Manager	Client
A	11/28/2016	60% Submittal	CMF	JG	JG	STD	
B	2/15/2017	75% Submittal	CMF	JG	JG	STD	

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SECTION 01320

CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 SUMMARY

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

1. Construction schedule.
2. Construction schedule updating reports.
3. Daily construction reports.
4. Site condition reports.

1.2 RELATED SECTIONS

A. Section 01330 – Shop Drawings, Product Data, and Samples

1.3 DEFINITIONS

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

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

B. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Project.

C. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.

D. Float: The measure of leeway in starting and completing an activity.

1. Float time belongs to Engineer.

1.4 INFORMATIONAL SUBMITTALS

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

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

B. Startup Network Diagram: Of size required to display entire network for entire construction period. Show logic ties for activities.

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

1. Submit a working electronic copy of schedule, using software indicated, and labeled to comply with requirements for submittals. Include type of schedule (initial or updated) and date on label.

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

E. Daily Construction Reports: Submit at weekly intervals.

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

1.5 COORDINATION

A. Coordinate construction schedule with the schedule of values, list of subcontracts, submittal schedule, progress reports, payment requests, and other required schedules and reports.

1. Secure time commitments for performing critical elements of the Work from entities involved.
2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

PART 2 - PRODUCTS

2.1 CONSTRUCTION SCHEDULE, GENERAL

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

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

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

1. Activity Duration: Define activities so no activity is longer than 20 days, unless specifically allowed.

2. Procurement Activities: Include procurement process activities for long lead items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
3. Submittal Review Time: Include review and resubmittal times indicated in Section 01330 in schedule. Coordinate submittal review times in construction schedule with submittal schedule.
4. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for administrative procedures necessary for certification of Substantial Completion.
5. Punch List and Final Completion: Include not more than 30 days for completion of punch list items and final completion.

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

1. Phasing: Arrange list of activities on schedule by phase.
2. Work under More Than One Contract: Include a separate activity for each contract.
3. Work by others: Include a separate activity for each portion of the Work performed by others.
4. Work Restrictions: Show the effect of the following items on the schedule:

    a. Coordination with existing construction.
    b. Limitations of continued occupancies.
    c. Uninterruptible services.
    d. Partial occupancy before Substantial Completion.
    e. Use of premises restrictions.
    f. Provisions for future construction.
    g. Seasonal variations.
    h. Environmental control.

5. Work Stages: Indicate important stages of construction for each major portion of the Work.

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

E. Upcoming Work Summary: Prepare summary report indicating activities scheduled to occur or commence prior to submittal of next schedule update. Summarize the following issues:

1. Unresolved issues.
2. Unanswered Requests for Information.
3. Rejected or unreturned submittals.
4. Notations on returned submittals.
5. Pending modifications affecting the Work and Contract Time.

F. Recovery Schedule: When periodic update indicates the Work is 14 or more calendar days behind the current approved schedule, submit a separate recovery schedule indicating means by which General Contractor intends to regain compliance with the schedule.

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

2.2 CONSTRUCTION SCHEDULE (GANTT CHART)

A. Gantt-Chart Schedule: Submit a comprehensive, fully developed, horizontal, Gantt-chart-type, construction schedule within 30 days of date established for the Notice of Award.

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

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

2.3 CONSTRUCTION SCHEDULE (CPM SCHEDULE)

A. General: Prepare network diagrams using AON (activity-on-node) format.

B. Startup Network Diagram: Submit diagram within 14 days of date established for the Notice of Award. Outline significant construction activities for the first 90 days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.

C. CPM Schedule: Prepare construction schedule using a time-scaled CPM network analysis diagram for the Work.

1. Develop network diagram in sufficient time to submit CPM schedule so it can be accepted for use no later than 60 days after date established the Notice of Award.

a. Failure to include any work item required for performance of this Contract shall not excuse General Contractor from completing all work within applicable completion dates, regardless of approval of the schedule.

2. Establish procedures for monitoring and updating CPM schedule and for reporting progress. Coordinate procedures with progress meeting and payment request dates.
3. Use "one workday" as the unit of time for individual activities. Indicate nonworking days and holidays incorporated into the schedule in order to coordinate with the Contract Time.

D. CPM Schedule Preparation: Prepare a list of all activities required to complete the Work. Using the startup network diagram, prepare a skeleton network to identify probable critical paths.

1. Activities: Indicate the estimated time duration, sequence requirements, and relationship of each activity in relation to other activities. Include estimated time frames for the following activities:

a. Preparation and processing of submittals.
b. Mobilization and demobilization.
c. Purchase of materials.

d. Delivery.
e. Fabrication.
f. Utility interruptions.
g. Installation.
h. Work by others that may affect or be affected by General Contractor's activities.
i. Testing and commissioning.
j. Punch list and final completion.
k. Activities occurring following final completion.

2. Critical Path Activities: Identify critical path activities, including those for interim completion dates. Scheduled start and completion dates shall be consistent with Contract milestone dates.
3. Processing: Process data to produce output data on a computer-drawn, time-scaled network. Revise data, reorganize activity sequences, and reproduce as often as necessary to produce the CPM schedule within the limitations of the Contract Time.
4. Format: Mark the critical path. Locate the critical path near center of network; locate paths with most float near the edges.

a. Subnetworks on separate sheets are permissible for activities clearly off the critical path.

E. Contract Modifications: For each proposed contract modification and concurrent with its submission, prepare a time-impact analysis using a network fragment to demonstrate the effect of the proposed change on the overall project schedule.

F. Initial Issue of Schedule: Prepare initial network diagram from a sorted activity list indicating straight "early start-total float." Identify critical activities. Prepare tabulated reports showing the following:

1. Work or activity.
2. Description of activity.
3. Main events of activity.
4. Immediate preceding and succeeding activities.
5. Early and late start dates.
6. Early and late finish dates.
7. Activity duration in workdays.
8. Total float or slack time.
9. Average size of workforce.
10. Dollar value of activity (coordinated with the schedule of values).

G. Schedule Updating: Concurrent with making revisions to schedule, prepare tabulated reports showing the following:

1. Identification of activities that have changed.
2. Changes in early and late start dates.
3. Changes in early and late finish dates.
4. Changes in activity durations in workdays.
5. Changes in the critical path.
6. Changes in total float or slack time.
7. Changes in the Contract Time.

2.4 REPORTS

A. Daily Construction Reports: Prepare and submit by 9:00am local Site time a daily construction report recording the following information concerning events at Project site:

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

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

PART 3 - EXECUTION

3.1 CONSTRUCTION SCHEDULE

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

1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
3. As the Work progresses, indicate final completion percentage for each activity.

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

1. Post copies in Project meeting rooms and temporary field offices.

2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

END OF SECTION

SPECIFICATION REVISION INDEX

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			Prepared By	Reviewed By	Project Engineer	Project Manager	Client
A	11/28/2016	60% Submittal	CMF	JG	JG	STD	
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SECTION 01330

SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Submission of all shop drawings and product data as required by the Contract Documents for all equipment and materials to be furnished under this Contract unless specifically indicated otherwise

1.2 RELATED SECTIONS

A. Section 01400—Quality Control

B. Section 01630—Product Options and Substitutions

C. Section 01730—Operation and Maintenance Data

1.3 DEFINITIONS

A. Supplier: Equipment Manufacturer or Material Supplier.

B. “Or-Equal” Items: Material or equipment proposed by General Contractor that is functionally equal to that named and sufficiently similar so that no change in related Work will be required.

C. Product Data: Product data are illustrations, standard schedules, performance charts, instructions, brochures, diagrams and other information furnished by the General Contractor to illustrate materials or equipment for some portion of the Work.

D. Samples: Physical examples that illustrate materials, equipment, or workmanship and establish standards by which the Work will be judged.

E. Shop Drawings: Shop Drawings are drawings, diagrams, schedules, and other data specifically prepared for the Work by the General Contractor, manufacturer, and supplier or distributor, to illustrate some portion of the Work.

F. Submittals: Documents or materials required by the Engineer to be provided for review prior to installing the components into the Work.

1. Action Submittal: Written and graphic information submitted by General Contractor that requires Engineer's approval.
2. Informational Submittal: Information submitted by General Contractor that requires Engineer's review and determination that submitted information is in accordance with the Conditions of the Contract and project-specific requirements

G. Substitutions: A request for use of an alternative system or procedure which is materially different than shown in the documents that provides performance equivalent to what is shown in the documents

1.4 GENERAL

A. Whenever an item of material or equipment is specified or described in the Contract Documents by using the name of a proprietary item or the name of a particular Supplier, the specification or description is intended to establish the type, function, appearance, and quality required.

B. Unless the specification or description contains or is followed by words reading that no like, no equivalent, or no "or-equal" item or no substitution is permitted, other items of material or equipment or material or equipment of other Suppliers may be submitted to Engineer for review. Product substitution requests must meet the same performance requirements as the specified product and are subject to review and approval by the Engineer.

C. Construction Schedule: Designate in the construction schedule, or in a separate coordinated Submittal Registry or shop drawing schedule, the dates for submission and the dates that reviewed Shop Drawings and Product Data will be needed.

D. Submittal Registry: Within 15 calendar days from the execution of contract a complete registry of anticipated submittals shall be delivered to Engineer. This registry shall include all items of work that will require approval, review and other required comments before said materials have been procured and/or delivered to the site.

1.5 SUBMITTALS

A. Electronic Submittals: Submittals shall, unless specifically accepted, be made in electronic format:

1. Each submittal shall be an electronic file in Adobe Portable Document Format (PDF). Use the latest version available at time of execution of the Agreement.
2. Electronic files that contain more than 10 pages in PDF format shall contain internal bookmarking from an index page to major sections of the document.

3. PDF files shall be set to open “Bookmarks and Page” view.
4. Add general information to each PDF file, including title, subject, author, and keywords. PDF files shall be text searchable (OCR’d).
5. PDF files shall be set up to print correctly (legible and correctly sized) at 8.5-inch by 11-inch, 11-inch by 17-inch, or 22-inch by 34-inch. No other paper sizes will be accepted.
6. Submit new electronic files for each resubmittal.
7. Include a copy of the Transmittal of General Contractor’s Submittal form, located at end of section, with each electronic file.
8. Provide Engineer with authorization to reproduce and distribute each file.
9. Detailed procedures for handling electronic submittals will be discussed at the preconstruction conference.

B. Shop Drawings—Drawings shall be presented in a clear and thorough manner:

1. Identify details by reference to sheet and detail, schedule or room numbers shown on Contract Drawings
2. Identify equipment by reference to equipment name and tag number shown on Contract Drawings
3. Scale and Measurements: Make drawings accurate to a scale with sufficient detail to show the kind, size, arrangement and function of component materials and devices
4. Minimum sheet size: 8-1/2 inch by 11 inch
5. Fabrication drawing size: 11 inch by 17 inch or 24 inch by 36 inch

C. Product Data—Preparation:

1. Clearly mark each copy to identify pertinent products or models submitted for review
2. Identify equipment by reference to equipment name and tag number
3. Catalog cut sheets: Cross-out or delete irrelevant data
4. Show performance characteristics and capacities
5. Show dimensions and clearances required for installation and maintenance
6. Show wiring or piping diagrams and controls
7. Show external connections, anchorages, and supports required

D. "Certificate of Compliance":

1. Provided by General Contractor in lieu of extensive or detailed submittal data required
2. Certifies that the product data or item identified in certificate is in total compliance with Contract Document requirements

3. Products or items applicable for Certificates of Compliance as scheduled at the end of this Section are subject to rejection in the field if found to deviate from the Contract Documents
4. Specifically identifies project name and guarantees that there is no deviation from Contract Documents
5. Catalog cut sheets: Cross-out or delete irrelevant data
6. Identify equipment by reference to equipment name and tag number
7. Identify limits of equipment, materials or work provided
8. Provide for specific product data or item only as scheduled herein
9. Attach copy of purchase order or invoice

E. Construction Schedule: Designate in the construction schedule, or in a separate coordinated shop drawing schedule, the dates for submission and the dates that reviewed Shop Drawings and Product Data will be needed.

F. General Contractor's standard schematic drawings and diagrams:

1. Modify drawings and diagrams to delete information which is not applicable to the Work by crossing out or omitting irrelevant data
2. Supplement standard information to provide information specifically applicable to the Work

1.6 GENERAL CONTRACTOR RESPONSIBILITIES

A. Review shop drawings and product data prior to submission for accuracy and completeness of each submission

B. Approve and stamp each submission before submitting it

C. Determine and verify:

1. Catalog numbers and similar data
2. Conformance with specifications and identification of all deviations
3. Confirm assignment of unit responsibility

D. Prior to each submission, carefully review and coordinate all aspects of each item being submitted

E. Verify that each item and the submittal for it conform in all respects with specified requirements of the Work and of the Contract Documents

F. Make submissions promptly in accordance with Construction Schedule, and in such sequence as to cause no delay in the Work or in the work of the General Contractor in accordance with Section 01320 – Construction Progress Documentation.

G. Limit requirements for expedited submittal review by Engineer to no more than 10 percent of total number of submittals:

1. Expedited submittal review period: Less than 21 calendar days

H. Notify Engineer in writing, at time of submission, of any deviations in the submittals from Contract Document requirements:

1. Identify and tabulate all deviations in transmittal letter
2. Indicate essential details of all changes proposed, including modifications to other facilities that may be a result of the deviation

1.7 SUBMISSION REQUIREMENTS

A. Make submissions far enough in advance of scheduled dates for installation to provide time required for reviews, for securing necessary approvals, for possible revisions and resubmissions, and for placing orders and securing delivery

B. In scheduling, allow a minimum of 21 calendar days for review by Engineer following receipt of submission in Engineer's office:

1. Time required to mail submissions or resubmissions is not considered apart of review period

C. Consecutively number all submissions:

1. Assign a unique number to include all shop drawings, product data and other information required for individual specification sections
2. Each specification section may still have more than one submittal number for later submissions (i.e., Preliminary O&M Manuals, Final O&M Manuals, etc.)

D. Accompany each submission with a letter of transmittal showing all information required for identification and checking. Submittals shall contain:

1. Submittal number
2. Date of submission and dates of any previous submissions
3. Project title and number
4. Engineer Contract identification number if applicable
5. The names of:
   a. General Contractor
   b. Supplier
   c. Manufacturer
6. Identification of the product, with the specification section number

7. Field dimensions, clearly identified as such
8. Relation to adjacent or critical features of the Work or materials
9. Applicable standards, such as ASTM or Federal Specification numbers
10. Identification of deviations from Contract Documents:
    a. If General Contractor proposes to provide material or equipment of work which deviates from the Contract Documents, indicate so under "deviations" on the transmittal form accompanying the submittal copies
    b. Identify all requested deviations as specified and on copies of Specifications and Drawings
    c. If deviations from specifications are indicated and, therefore requested by General Contractor, the submittal shall be accompanied by a detailed, written justification for each deviation
    d. Failure to include a copy of marked-up specification sections with the submittal, along with justification for any requested deviations to specification requirements, shall be cause for rejection of the entire submittal with no further consideration by Engineer
11. Identification of revisions on resubmissions
12. An 8 inch by 4 inch blank space for Engineer's stamps
13. Stamp cover sheet of each submittal as identified in letter of transmittal
14. General Contractor's stamp: Initialed or signed, certifying review and approval of submittal, verification of products, and coordination of the information within the submittal with requirements of the Work and of Contract Documents. Use stamp to include wording similar to the following:

This submittal has been reviewed by [*name of General Contractor*] and approved with respect to the means, methods, techniques, sequences, and procedures of construction, and safety precautions and programs incidental thereto. [*Name of General Contractor*] also warrants that this submittal complies with contract documents and comprises no deviations thereto: Section No: _____ Submittal No: _____ Date: _____ by: _____

E. Submittal Log:

1. Maintain an accurate submittal log for duration of the Work showing current status of all submissions
2. Show submittal number, section number, section title, submittal description dates and disposition of submittal

3. Make submittal log available to Engineer for review upon request

F. Unless specified otherwise, make submissions in groups to facilitate efficient review and approval:

1. Include all associated items from individual specification sections to assure that all information is available for checking each item when it is received
2. Submit a complete initial submittal including all components when an item consists of components from several sources
3. Partial submittals may be rejected as not complying with provisions of the Contract
4. Engineer will not be held liable for delays due to poorly organized or incomplete submissions
5. Do not include items from more than one specification section for any one submittal number

G. Engineer may require General Contractor to provide drawings, setting diagrams and similar information to help coordinate the Work, but such data shall remain with General Contractor and will not be reviewed by Engineer unless specifically called for within the Contract Documents

H. All submittals for each component of multi-component systems shall be compiled and submitted through the General Contractor to the Engineer by the manufacturer having System Responsibility

1.8 DISPOSITION OF SHOP DRAWINGS AND PRODUCT DATA

A. "Approved As Submitted": Approved with No Exceptions Noted:

1. Electronic copy returned to General Contractor for his use:
   a. One hard copy to be kept on file at Engineer’s office at job site
2. No corrections or comments noted on submittal or in transmittal letter
3. Issues or miscellaneous comments pertaining to other related items of the Work may be included in transmittal letter
4. Resubmission not required

B. "Exceptions Noted": Approved with Corrections Noted:

1. Electronic copy returned to General Contractor for his use:
   a. One hard copy to be kept on file at Engineer office at job site
   b. Copies of submittal data in operation and maintenance manuals to be revised according to corrections

2. Comply with corrections or comments as noted on submittal and in transmittal letter
3. Resubmission not required

C. "Revise And Resubmit": Incorrect or Specific Information Still Required:

1. Copy of transmittal letter sent to Engineer. An "Approved As Submitted" or "Exceptions Noted" submittal will be forwarded to Engineer upon resubmission and review per above disposition requirements
2. Submittal is either: incorrectly annotated; specific comments need to be addressed and incorporated in resubmittal; and/or additional information may be required as noted in transmittal letter
3. Submitted information may not include or address specific item required per the specification as identified in transmittal letter
4. Specific information related to identified item may be required for final approval of submittal
5. Resubmission of entire submittal may be required or resubmission of specific item may be required as identified in transmittal letter

D. "Rejected": Returned for Correction:

1. Copy of transmittal letter sent to Engineer
2. General Contractor required to resubmit complete submittal package in accordance with Contract Documents
3. Submittal does not comply with provisions of Contract Documents as noted in transmittal letter
4. Resubmission required

E. "Receipt Acknowledged": For Reference Purposes Only or for Record Copy:

1. Applicable to Certificates of Compliance, manufacturer and/or General Contractor provided calculations, and other miscellaneous documentation not subject to Engineer review
2. Copy of transmittal letter sent to Engineer
3. Detailed review and comment by Engineer not required
4. Resubmission not required

1.9 RESUBMISSION REQUIREMENTS

A. Make any corrections or changes in submittals required by Engineer and resubmit until approved

B. Transmit each resubmission under new letter of transmittal. Use number of original submittal followed directly by a capital letter corresponding to the number of times a submittal is resubmitted (i.e., 1, 1A, 1B, etc.)

C. Shop Drawings and Product Data:

1. Revise initial drawings or data and resubmit as specified for the initial submittal
2. Indicate any changes which have been made other than those requested by Engineer

D. Reimbursement of Resubmission Review Costs:

1. Review of first submittal and one resubmittal will be performed by Engineer at no cost to the General Contractor
2. Costs for review of subsequent resubmissions will be directly paid by General Contractor
3. Charges for review of resubmissions will include Submittal Clerk at maximum rate of $65 per hour

1.10 ENGINEER'S DUTIES

A. Review submittals with reasonable promptness and in accord with approved submission schedule provided that each submittal has been called for by the Contract Documents and is stamped by General Contractor as indicated above:

1. In the event that Engineer will require more than 21 calendar days to perform an expedited submittal review as requested by General Contractor, Engineer shall so notify General Contractor or indicate so on the submission schedule
2. No extensions of time are allowed due to Engineer’s delay in reviewing submittals unless all the following criteria are met:
    a. General Contractor has notified Engineer in writing that an expedited review of particular submittal in question is critical to the progress of the Work and General Contractor has identified the requested submittal return date.
    b. Engineer has failed to return submittal within 21 days of receipt of the submittal or receipt of said notice, whichever is later
    c. General Contractor demonstrates that delay in progress of the Work was directly attributable to Engineer’s failure to return submittal within 21 days
3. No extensions of time are allowed due to delays in progress of the Work caused by rejection and subsequent resubmission of data, including multiple resubmissions

B. Review drawings and data submitted only for general conformity with Contract Documents:

1. Engineer's review of drawings and data returned marked "Approved As Submitted" or "Exceptions Noted" does not indicate a thorough review of all dimensions, quantities, and details of material, equipment device or items shown
2. Engineer's review does not relieve General Contractor of responsibility for errors, omissions or deviations nor responsibility for compliance with the Contract Documents

C. Assume that no shop drawing or related submittal comprises a deviation to the Contract Documents unless General Contractor advises Engineer otherwise in writing which is acknowledged by Engineer in writing:

1. Consider and review only those deviations from the Contract Documents clearly identified as such in submittal and tabulated in the Letter of Transmittal
2. At the discretion of the Engineer, notify General Contractor that review of specific deviations will be reviewed under provisions of Section 01630

D. Return submittals to General Contractor for distribution or for resubmission

E. Transmit, unreviewed, to General Contractor all copies of submittals received from other suppliers and manufacturers

F. Transmit, unreviewed, to General Contractor all copies of submittals not called for by the Contract Documents or which have not been approved by Engineer

G. Engineer will not review uncalled-for shop drawings, product data or Certificates of Compliance except by special arrangement

H. Affix stamp and indicate approval for submittal or resubmission requirements with the following stamp:

□ Approved As Submitted	□ Exceptions Noted
□ Revise And Resubmit	□ Rejected

This review was performed only for general conformance with the design concept of the project and general compliance with the information given in the Contract Documents. Modifications or comments made on the shop drawings and product data during this review do not relieve General Contractor from responsibility for compliance with the requirements of the plans and specifications. Approval of a specific item does not include approval of the assembly of which the item is a component. General Contractor is responsible for: dimensions to be confirmed and correlated at the jobsite; information that pertains solely to the fabrication processes or to the means, methods, techniques, sequences, and procedures of construction; coordination of the work of all trades; and for performing all work in a safe and satisfactory manner.

Tetra Tech, Inc.

Date _____By _____

1.12 SUBMITTAL SCHEDULE

A. Unless indicated otherwise, provide all submittals required by individual sections of the Contract Documents to establish compliance with the specified requirements

B. Provide “Certificate of Compliance” in lieu of product data submittal for the following sections: (Not Applicable)

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

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SECTION 01370

SCHEDULE OF VALUES

PART 1 GENERAL:

1.01 DESCRIPTION OF WORK:

A. General Contractor shall prepare a Schedule of Values for the Project for review and approval.

1.02 RELATED WORK:

A. Section 01270 – Measurement and Payment

1.03 SUBMITTALS:

A. General Contractor Submittals

1. A preliminary Schedule of Values (Schedule) shall be submitted to Engineer, in triplicate, prior to or at the Pre-Construction Conference. The Schedule shall be a breakdown of each bid item and may be used to verify costs of credits, change orders, etc.

2. The preliminary Schedule will be reviewed by the Engineer for acceptance. The Schedule shall include sufficient detail, as decided by the Engineer, to determine if the prices included are “unbalanced” or “front-end loaded”. Inflation of prices for those items of work to be completed in the early stages of work shall not be acceptable.

3. The Engineer will provide the General Contractor with comments and may request additional information from the General Contractor to justify certain item quantities and prices thereof. The General Contractor shall revise and resubmit the Schedule addressing all the Engineer’s comments until final acceptance by the Engineer.

4. The final approved Schedule of Values shall become the Schedule used in determining partial payment estimates.

5. No partial payment requests (including the first) shall be approved until the final Schedule of Values has been approved by the Engineer.

6. After acceptance of the final Schedule of Values, no modifications will be made to the Schedule, except as required by approved change orders.

B. Partial Payment Requests

1. Each partial payment request submitted by the General Contractor shall include the approved Schedule of Values, modified to indicate the total quantity and price of the work completed up to the date of the request.

1.04 FORMAT

A. In so far as possible, total quantities and unit prices shall be shown for all items of work, separating for each item the materials and labor and such other sub-items the General Contractor may desire.

B. “Lump Sum” and “miscellaneous” and other such general entries in the Schedule shall be avoided whenever possible.

C. Such items as Bond premiums, insurance, temporary facilities and equipment storage may be listed separately in the Schedule provided the costs can be substantiated.

D. Overhead and profit shall not be listed as separate items in the Schedule.

E. Breakdown costs to list major products or operations for each line item which has an installed value of more than $5,000.00.

F. The sum of the items listed on the Schedule shall equal the contract lump sum price. The value for mobilization costs listed in the Schedule shall not exceed three (3) percent of the total contract price. No additional payment will be allowed if the quantities shown on the Schedule are less than those actually required to accomplish the work, unless the quantities are altered by a change order.

1.05 FORECAST OF PAYMENTS

A. Within thirty (30) days after the award of the Contract, prepare and submit to the Engineer a chart forecasting the monthly partial payment amounts that are anticipated for this project. During progress of the job, mark this chart to show actual payments to date and revise the forecast of payments as necessary and submit the revised chart to the Engineer monthly.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION – NOT USED

END OF SECTION

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SECTION 01400

QUALITY CONTROL

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Quality assurance and control of installation

B. General Contractor's responsibilities

C. General Contractor's field services and reports

D. Shop testing

E. Field testing

F. Testing and services schedule

G. Submission of all shop drawings and product data as required by the Contract Documents for all equipment and materials to be furnished under this Contract unless specifically indicated otherwise

1.2 RELATED SECTIONS

A. Section 01330—Shop Drawings, Product Data, and Samples

B. Section 01600—Common Product Requirements

C. Section 01630—Product Options and Substitutions

D. Section 01640—Manufacturer’s Field Services

E. Section 01730—Operation and Maintenance Data

F. Division 11 & 13 – Equipment Specifications

1.3 REFERENCES

A. Conform to reference standard by date of issue current on date of Contract Documents

B. Obtain copies of standards when required by Contract Documents

C. Where specified reference standards conflict with Contract Documents, request clarification for Engineer before proceeding

D. The contractual relationship of the parties to the Contract shall not be altered from the Contract Documents by mention or inference otherwise in any reference document

1.4 SUBMITTALS

A. Submit under provisions of Section 01330

B. Provide copies of written reports for materials, equipment or systems as scheduled at the end of this section. Reference each report by respective section number

C. Field personnel qualifications—Provide statement of qualifications for review and acceptance by Engineer for the following:
   1. Independent special inspector and testing as specified
   2. General Contractor field representative

D. Shop test reports: Provide reports detailing results of tests and certification from manufacturer to verify compliance with specifications

E. Field test reports: Provide reports detailing results of the tests. Indicate compliance or non-compliance with Contract Documents. Identify corrective action for materials and equipment which fails to pass field tests

F. General Contractor's field services:
   1. Provide qualifications of observer to Engineer 30 days in advance of required observations. Observer subject to acceptance of Engineer
   2. Provide reports to Engineer certifying that:
      a. Equipment is properly installed and lubricated
      b. Equipment is in accurate alignment
      c. Equipment is free from any undue stress imposed by connecting piping and anchor bolts
      d. Equipment has operated satisfactorily under full load conditions

1.5 QUALITY ASSURANCE/CONTROL OF INSTALLATION

A. Monitor quality control over installers, suppliers, manufacturers, products, services, site conditions, and workmanship to produce Work of specified quality

B. Comply with specified standards as a minimum quality for the Work except when more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship

C. Inspections and testing required by laws, ordinances, rules, regulations, orders or approvals of public authorities as specified in the Contract Documents

D. Certification of products: In compliance with equipment specified in Divisions 11 and 15 and Section 01600 – Common Product Requirements

E. Testing, adjusting and balancing of equipment: In compliance with requirements of Section 01600 and this Section.

1.6 ENGINEER'S RESPONSIBILITIES

A. Cooperate with laboratory personnel and provide access to Work

B. Furnish incidental labor and facilities:
   1. To provide access to Work to be tested
   2. To obtain and handle samples at the project site or at the source of the product to be tested
   3. To facilitate inspections and tests

C. Cooperate with independent firm; furnish samples of materials, design mix, equipment, tools, storage and assistance as requested:
   1. Notify independent firm 24 hours prior to expected time for operations requiring services to allow for scheduling of tests and laboratory assignment of personnel
   2. Make arrangements with independent firm and pay for additional samples and tests required for Engineer's use

1.7 MANUFACTURER'S FIELD SERVICES

A. Comply with provisions under Section 01640.

B. Engineer shall coordinate and pay for the services of Manufacturer's representatives to perform the specified services

C. When specified in individual specification Sections, require material or product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, startup of equipment, testing, adjusting and balancing of equipment and, as applicable, to initiate instructions when necessary

D. Individuals to report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturer's written instructions

E. Qualification of Manufacturer's Representative: Authorized representative of the material or product supplier; experienced in the application and installation of the subject equipment

F. Inspect, check and adjust equipment as required and approve installation

G. Be present when equipment is placed in operation

H. Revisit the site as often as required to correct all problems and until equipment installation and operation are acceptable to Engineer

I. Instruct Engineer's personnel in operation and maintenance of the equipment in accordance with Section 01730 and respective sections of specifications

1.8 SHOP TESTS

A. General Contractor shall coordinate and pay all costs associated with specified shop tests of equipment, including retesting of items which fail original tests specifically identified in the technical specifications

B. Where the specifications call for a shop test to be witnessed by a representative of the Engineer, notify Engineer not less than 14 days prior to the scheduled test date:
   1. Engineer is to pay for all costs of Engineer's first visit
   2. When subsequent visits by Engineer are required because of incomplete tests, retesting or subsequent tests, General Contractor shall reimburse Engineer for all costs of the subsequent visits

1.9 FIELD TESTING

A. Engineer shall pay all costs associated with field testing of materials and equipment as required in respective sections of the specifications

B. Provide all required materials, labor, equipment, water, and power required for testing

C. Perform all tests in presence of Engineer and provide one copy of field test results to Engineer same day of tests

D. Repair with no additional compensation all materials and equipment which fail during testing

1.10 TESTING AND SERVICES SCHEDULE

A. Testing laboratory services shall be provided for, but shall not be limited to, the following:

Specification Section	Type of Material, Equipment or System

Not Used

1.11 SHOP TESTING

A. Shop testing shall be provided for the following:

Specification Section	Type of Material, Equipment or System

Not Used

1.12 MANUFACTURER'S FIELD SERVICES

A. Manufacturer's field services shall be provided for, but shall not be limited to, the following:

Specification Section	Type of Material, Equipment or System
11210	Multi-Media Filters
11220	Ion Exchange System
11290	Cyclone
11295	End-Suction Centrifugal Pumps
11315	Progressing Cavity Pumps

1.13 FIELD TESTING

A. Field testing shall be provided for, but shall not be limited to, the following:

Specification Section	Type of Material, Equipment or System
11210	Multi-Media Filters
11220	Ion Exchange System
11290	Cyclone
11295	End-Suction Centrifugal Pumps
11315	Progressing Cavity Pumps

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

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SECTION 01450

SPECIAL INSPECTIONS AND TESTING

PART 1 GENERAL

1.1 SECTIONS INCLUDES

A. The intent of this Specification is to describe the Engineering Services and work required to perform sampling, testing and inspection of concrete materials, mix designs, concrete, earthwork materials, earthwork, and to perform inspection and testing for structural steel and miscellaneous metal erection for the Weir Dewatering Project, located in Henderson, Nevada.

B. The Engineer will furnish Design Drawings and Specifications to the Testing Representative awarded the work hereunder. These documents will be furnished at various intervals throughout the performance of the work of this service agreement.

C. These documents, which define the construction work to be performed by others at the project site, shall be used by the Testing Representative only as reference material.

1.2 DEFINITIONS

A. Testing Representative: Individual, partnership or corporation selected to perform the scope of work as defined in this specification. The testing representative shall be qualified by training and experience and hold certifications or documentation of their qualifications.

1.3 DOCUMENTATION AND SUBMITTALS

A. Test inspection reports:
   1. Reports of all tests and/or inspections performed under this Specification, both field and laboratory, shall be furnished to the Engineer on a scheduled basis. Except where the results of any individual test, group of tests or the results of an inspection must be immediately made known to the Engineer within 24 hours (e.g., failure of concrete compressive strengths), submittal of test and inspection reports shall be on a weekly basis. Each submittal shall, as a minimum, cover all tests and inspections performed or completed during the previous seven (7) calendar days. The original report shall be signed and sealed by a Professional Engineer registered in the State of Nevada.
   2. The submittal of test and/or inspection reports shall include detailed descriptions of any work by others which is or was rejected due to inspection or testing by the

Testing Representative and reason for the Testing Representative's rejection of such work.

B. Submittal of data:
   1. The Testing Representative shall submit all test and inspection reports which have been prepared in performance of the work specified herein. Reports may be in Testing Representative's own format, but will be subject to approval of the Engineer. Reports shall be entirely legible and suitable for photocopy reproduction by the Engineer. Submittal of reports shall be as follows:
      a. Two (2) copies to Engineer.
      b. One (1) copy to General Contractor (supplying or performing the work tested).

C. Test records:
   1. Throughout the performance of the work, the Testing Representative, unless otherwise directed by the Engineer, shall maintain at the jobsite one (1) complete set of all reports, data and records of testing performed hereunder. The Testing Representative shall allow the Engineer unrestricted access to these records.

1.4 AUTHORITY TO REJECT

A. The General Contractor's Inspector shall have authority to reject all materials and workmanship not conforming to the Design Drawings and/or Specifications. Any defective material found during the progress of the work shall be promptly replaced or corrected by the General Contractor to the satisfaction of the General Contractor’s Inspector and Engineer.

PART 2 PRODUCTS

2.1 GENERAL

A. The Testing Representative awarded the work shall serve as the sampling, testing, and inspection agent for the General Contractor and will be under the direct supervision of the General Contractor, performing all sampling, testing and inspection as herein specified and as required by the Engineer to maintain quality control of work performed by others in construction of the Project. As part of accomplishing the foregoing functions, the Testing Representative shall:
   1. Provide and maintain laboratory and office facilities adequate for meeting the testing needs of the Project, including peak periods of construction.
   2. Provide and maintain during actual periods of sampling and testing, in the Testing Representative's home office or jobsite field laboratory, a Professional Engineer registered in the State of Nevada to supervise all technicians or personnel performing sampling, testing and inspection.

3. Provide at the jobsite, during the actual period of sampling and testing, sufficient properly qualified and suitably equipped personnel to accomplish, without delays in construction, all necessary sampling, field testing and inspection.
4. Assume full responsibility for taking, caring for, storing and transporting samples and test cylinders.
5. Perform the following:
    a. Sampling and testing of concrete aggregates, fibrous reinforcement, cement, admixtures and curing agents as necessary to determine compliance of materials with specification requirements.
    b. Slump testing of concrete as discharged from transport vehicles.
    c. Determining unit weight of concrete as discharged from transport vehicles.
    d. Monitoring temperature of delivered concrete.
    e. Determining air content of concrete as discharged from transport vehicles.
    f. Making, curing and strength testing of concrete test cylinders.
    g. Making curing and strength testing of grout test samples.
    h. Inspection of reinforcing steel prior to concrete placement.
    i. Inspection of cast-in-place anchor rods prior to and during concrete placement.
    j. Inspection of post-installed anchors in hardened concrete during anchor installation.
    k. Determine in-place density and moisture content of compacted soils.
    l. Inspection of Field Welded connections.
    m. Measure tension in tightened high-strength bolts (A325/A490) by means of a Skidmore-Wilhelm device.
    n. Verification testing of high-strength bolt/nut assemblies.
    o. Inspection of high-strength bolts, nuts and washers as specified herein.
    p. Verification testing of Direct Tension Indicators.
    q. Inspect installed high-strength bolts and Direct Tension Indicators.

B. Submit reports as specified in Paragraph 1.3.

C. Furnish all labor, tools, equipment and supplies for accomplishing the foregoing.

2.2 CODES AND STANDARDS

A. Unless noted below, the issues in effect as of January 2016 of the Codes, Standards and Publications of the following organizations form a part of this specification to the extent indicated by the references thereto:

1. International Building Code (IBC) – 2012 edition
2. American Concrete Institute (ACI)
3. American Society for Testing and Materials (ASTM)
4. Research Council on Structural Connections (RCSC)
5. American Institute of Steel Construction (AISC)
6. International Plumbing Code (IPC) – 2012 Edition
7. American Welding Society (AWS)

B. Project Specifications:
1. Section 02200 Earthwork
2. Section 02224 Subgrade Preparation
3. Section 02500 Paving and Surfacing
4. Section 03300 Concrete
5. Section 03600 Grout
6. Section 05120 Structural Steel Framing and Misc. Metals

C. Should a conflict be found to exist between any applicable portion of the referenced codes and standards and these specifications, the conflict shall be submitted to the Engineer for resolution before proceeding with the affected work.

PART 3 TESTING AND INSPECTION - CONCRETE

3.1 MATERIALS TESTING

A. Materials shall be inspected, sampled and tested by the Testing Representative in accordance with the requirements of the specification under which each material is furnished. Unless otherwise specified, applicable test methods and frequency of sampling and testing shall be compatible with and include the following minimum requirements:

Material	Applicable Test Method	Frequency of Sampling and Testing	Results Required
Cement	ASTM C150	*	Compliance w/spec
Concrete Aggregates	ASTM C33	**	Compliance w/spec
Membrane-Forming Curing Compounds	ASTM C309	*	Compliance w/spec
Air Entraining Admixtures	ASTM C260	*	Compliance w/spec
Water Reducing Admixture	ASTM C494, Type A	*	Compliance w/spec

* Test shall be run only when directed in writing by the Engineer.

** The complete test may be run once at the start of the Project and/or if there is a change in the source of aggregate. The complete test will not be run if the aggregate source has been tested and certified by the General Contractor. Visual inspection, sieve analysis and material finer than No. 200 tests will be conducted at least once a month or more frequently as directed by the Engineer.

B. The Engineer reserves the right to direct the Testing Representative to sample and test at a greater frequency than that specified as required by the Engineer.

3.2 CONCRETE INSPECTION, SAMPLING AND TESTING

A. The Testing Representative shall perform the inspection, sampling and testing of concrete as specified herein. Each technician performing such inspection shall serve as the General Contractor's representative and shall certify on the delivery ticket, or other report, the acceptance or rejection of each load of concrete. Rejected concrete shall not be placed in the work.
   1. Pre-placement visual inspection:
      a. Each batch of concrete shall be visually inspected at point of discharge from the transport vehicle. The delivery ticket for each batch shall be checked to insure that the concrete being delivered is the proper class for the intended use as required by the Design Drawings and Specifications.
      b. Visual inspection of the reinforcing bars shall be conducted prior to concrete placement. The inspection shall include, but not be limited to, the use of the required bars, bar size, spacing, splicing, cover and bar supports. Visual inspection shall also be made for the placement of anchor rods, embeds, piping, conduit, floor drains and any other applicable embedded items related to the concrete.
      c. The inspection of reinforcing steel and embedded item placement shall be made to determine that the placements have been made in accordance with the Design Drawings, Specifications, Codes and Standards.
   2. Pre-placement tests and measurements:
      a. The first batch of each class of concrete produced each day and at least every 50 cubic yards delivered thereafter shall be sampled and tested as follows.
      b. Slump test in accordance with ASTM C143, "Standard Test Method for Slump of Hydraulic-Cement Concrete".
         1) Entrained Air Content in accordance with ASTM C231, "Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method."
         2) The temperature of all concrete sampled shall be determined and recorded.

B. Rejection of concrete:

1. Any concrete that does not meet the requirement of its Class as set forth in its specification, when tested as specified above, shall be rejected.
2. Any concrete which has not been discharged from the delivery vehicle within ninety (90) minutes after being batched shall be rejected except during periods of hot weather as defined by ACI 305, the time limit shall be forty-five (45) minutes or commencement of initial set, whichever occurs first.
3. The Testing Representative shall immediately notify the General Contractor when any concrete is rejected.

C. Strength tests during the work:
1. The Testing Representative shall perform strength tests of the concrete following ASTM C172, ASTM C31 and ASTM C39. Slump, air content, temperature and unit weight shall be determined for each sample of concrete that is to be used for a strength test.
2. A strength test shall consist of the average of two cylinders from the same sample tested at the same age. A set of cylinders for strength testing shall consist of six (6) cylinders with two (2) cylinders being designated as spares to be used in place of a defective cylinder at either the seven (7) or the twenty-eight (28) day test; or at testing at 14 day test.
3. Strength tests of cylinders aged seven (7) days and twenty-eight (28) days shall be recorded throughout the duration of the work for each day concrete is placed for the following quantities of each class of concrete placed.

Placement	No. of Tests
Less than 25 cu. yd. per day	Engineer may waive test requirement
Less than 50 cu. yd. per day	One set for testing at 7 and 28 days
For each additional 50 cu. yd. or fraction thereof	One set for testing at 7 and 28 days
For each 5000 sq. ft. of surface area of slabs or walls	One set for testing at 7 and 28 days

4. Minimum number of strength tests shall be as per ACI 318, Section 5.6.2.
5. Additional tests may be requested by the Engineer to verify adequacy of curing and protection of concrete or to verify strength of concrete to permit early stripping of forms.
6. The Testing Representative shall notify the General Contractor immediately by telephone or in person and submit written recommendations for corrective action within twenty-four (24) hours when a strength test indicates any of the following:

a. The twenty-eight (28)-day compressive strength of any test is less than the specified strength.
b. The strength of cylinders tested to verify curing and protection methods is less than 85% of companion laboratory cured cylinders.

7. Since seven (7) day strength tests give an indication of the twenty-eight (28) day strength, the Testing Representative shall notify the General Contractor immediately by phone or in person when seven (7) day strength tests fall below the following percentage of the specified twenty-eight (28) day strengths:

Cement Type	Percent
I	70
II	60
III	80
IV	50
V	60

D. Obtaining and testing drilled cores:
1. Where the results of the strength tests of the test specimens indicate that the concrete as placed does not meet specified strength requirements, or where, in the opinion of the Engineer, there is other evidence that the quality of the concrete is below specification requirements, the General Contractor may direct the Testing Representative to obtain and test drilled cores in accordance with ASTM C42 as required by the Engineer. Results of tests on drilled cores shall be submitted as part of Testing Representative's weekly test reports submitted to the General Contractor and Engineer.

3.3 GROUTING INSPECTION, SAMPLING AND TESTING

A. The Testing Representative shall perform the inspection, sampling and testing of grouting placement as specified herein to verify the suitability of materials, grout mixture and adequacy of the in-place grout.
1. As a minimum, the following tests shall be conducted for non-shrink cement-based grout:
a. Three sets of three test cubes shall be made in the field each day that grout is mixed and placed. One cube set shall be tested at 7 days, one cube set tested at 28 days and one cube set designated as a spare. Compressive strength shall be tested in accordance with ASTM C109.
2. As a minimum, the following tests shall be conducted for epoxy grout:

a. Three sets of three test cubes shall be made in the field each day that grout is mixed and placed. One cube set shall be tested at 24 hours, one cube set tested at 3 days and one cube set tested at 7 days. Compressive strength shall be tested in accordance with ASTM C579, Method B and linear shrinkage in accordance with ASTM C531.

3. The Testing Representative shall report test results, recommendations for acceptance or rejection and recommendations for improvement or corrective measures to the General Contractor.

B. Additionally, refer to IBC 2012 Table 1705.3 for required continuous and periodic verification and inspection of concrete construction.

PART 4 TESTING AND INSPECTION - EARTHWORK

4.1 SOILS SAMPLING AND TESTING

A. Testing to determine suitability of earthwork materials:

1. The Testing Representative shall, as directed by the General Contractor, determine the suitability of earthwork materials to be furnished and used on the Project site. These tests, performed in sufficient quantity and frequency to determine that suitability is being met or maintained, shall include, but limited to: determination of liquid limit, plastic limit, and plasticity index in accordance with ASTM D4318, and abrasion and soundness according to ASTM C131, ASTM C535 and ASTM C88. Moisture-density relations shall be determined in accordance with ASTM D698, ASTM D1557 or ASTM D4253 and D4254 as required. Definitions of suitable materials shall be as specified in the attached *Report of Geotechnical Investigation*, dated June 5, 2015, prepared by Tetra Tech, Project Specifications and shown on the Design Drawings which will be furnished to the Testing Representative for the work of this sampling and testing service agreement.

B. Inspection to determine suitability of exposed soil strata for its intended use:

1. The Testing Representative shall inspect all excavations for structures and pipe and all subgrade preparation to determine that the proper soils strata has been exposed and that the material exposed is satisfactory for its intended use as shown on the Design Drawings. When any non-conformance is observed it shall be reported to the Engineer. The frequency and location of such inspections shall be included in the weekly reports submitted by the Testing Representative to the General Contractor and Engineer.

C. Construction control testing, and inspection:

1. During periods of the earthwork operation when material is being placed in a structural fill, backfill sub-base or any other area where a compaction requirement

is shown on the Design Drawing, or stated in the specification, the Testing Representative shall perform in-place density tests on the material that has been placed. The frequency of testing shall be as directed by the Engineer but sufficient tests shall be taken to insure that the equipment being used, and the procedures being employed, result in the required compaction. As a minimum, density tests shall be performed every 200 sq. yards of each layer of compacted fill placed for each major foundation.

2. The Testing Representative shall observe and inspect the fill material to insure compliance with the Specification.
3. The Testing Representative shall observe the fill placement procedure to insure that there is no deviation from the established procedure which is known to produce the desired results.
4. Field (in-place) density test of compacted materials shall be performed in accordance with ASTM D1556 (Sand-Cone Method), ASTM D2167 (Rubber-Balloon Method), or ASTM D2922 (Nuclear Method).

D. Additionally, refer to IBC 2012 Table 1705.6 for required continuous and periodic verification and inspection of soils.

PART 5 TESTING AND INSPECTION – STRUCTURAL STEEL

5.1 TESTING OF DIRECT TENSION INDICATORS (COMPRESSIBLE-WASHER-TYPE)

A. The Testing Representative shall be responsible for field testing each lot of Direct Tension Indicators that will be used in the installation of high-strength bolts for field connections of the structural steel.

B. The Testing Representative shall test three (3) washers from each lot for each bolt diameter in a Skidmore-Wilhelm device to ascertain that the Direct Tension Indicator, when installed in the same manner as they will be installed in the structure, will result in a bolt tension as tabulated in Table 7.1 of the RCSC Specification for Structural Joints using High-Strength Bolts when the gap has been closed to the measurement specified by the manufacturer of the Direct Tension Indicator.

1. Impact wrenches shall be set to tighten the bolt and flatten the protrusions on the Direct Tension Indicator to the specified measurement in ten seconds or less after the wrench begins to impact.

5.2 INSPECTION OF HIGH-STRENGTH BOLTS, NUTS, WASHERS AND DIRECT TENSION INDICATORS

A. The Testing Representative shall inspect each shipment of high-strength bolt, nut and washer assemblies including direct tension indicator washers if applicable.

B. The Testing Representative shall ascertain that all certification and test documentation as required by the Project Specifications has accompanied the shipment and that the documents are applicable and traceable to the particular shipment.

C. The Testing Representative shall ascertain that all high-strength bolts have been shipped, properly packaged, assembled as a unit with nut and washer (and Direct Tension Indicator, if required) and that the bolts and nuts are lubricated in accordance with the specification requirements.

D. The Testing Representative shall be prepared to perform rotational capacity tests on bolt assemblies, as required by ASTM A325, if required for field verification.

5.3 INSPECTION OF BOLTED STEEL CONNECTIONS

A. General:
   1. The Testing Representative shall inspect the work of the steel erector to insure that proper "bolt up" procedures are followed at all times. Installation and tightening procedures shall comply with the requirements of the RCSC specification and the AISC code.
   2. High-strength bolts in pre-tensioned (bearing-type) and slip-critical connections:
      a. All plies of each connection are to be brought into snug contact prior to final tightening of the bolts.
      b. Tightening of the bolts shall begin at the most rigid part of the connection and work outward until all bolts are tightened. On large connections (over 10 bolts) the bolts should only be tightened to approximately 50% of the final tension and the tightening cycle should be repeated to obtain the final tension load in the bolt.
      c. Direct Tension Indicators are to be installed in strict conformance to the manufacturer's recommendations.
      d. The Testing Representative shall visually inspect 100% of the high-strength bolts in each connection to insure that the protrusions on the Direct Tension Indicators have been flattened to the proper extent.
      e. Calibrated wrench pre-tensioning requires the inspector to observe the pre-installation verification testing at the beginning of each shift and shall be insured by routine observation that the bolting crew properly applies the calibrated wrench to the turned element.
   3. Common and high-strength bolts in snug-tightened (bearing-type) connections:
      a. Snug-Tightened (Bearing-Type) connections need only to be tightened to the snug tight condition. The snug tight condition is defined as the tightness that exists when all plies in a joint are in firm contact. The Testing Representative shall visually inspect 100% of the Snug-Tightened (Bearing-Type) connections to verify that the plies of the connected elements have been brought into snug contact.

B. Testing of bolted steel connections:
   1. Pre-tensioned (bearing-type) and slip-critical connections:
      a. Visual inspection according to manufactures recommendations of properly calibrated “Self Indicating” Direct Tension Indicators (Squirter type) shall be sufficient inspection of the bolted connection:
         1) The Testing Representative shall measure the average gap of the installed non-“Self Indicating” (Standard) Direct Tension Indicator in at least 10% of the bolts, but not less than two (2) bolts, in each connection. When the bolt is properly tightened, the resulting average gap shall be the gap specified by the manufacturer of the Direct Tension Indicator or less.
         2) A calibrated Feeler Gauge shall be used as a "go" or "no-go" tool. If the Gauge does not enter the gap, the installation will be considered satisfactory.

   2. Snug-tightened (bearing-type) connections:
      a. No testing of Snug-Tightened (Bearing-Type) connections is required other than the visual inspection listed in 3.4.5.C.

5.4 INSPECTION OF FIELD WELDED STEEL CONNECTIONS

A. Field welding shall not be permitted unless shown on the approved Design Drawings, or directed in writing by the Engineer of Record.

B. All welders and tackers for the work described herein shall be qualified in accordance with AWS D1.1. All inspectors used for visual weld inspection shall be certified in accordance with the provisions of AWS QC1, Standard for Qualification and Certification of Welding Inspectors. Personnel performing nondestructive testing shall be qualified in accordance with the current edition of American Society for Nondestructive Testing Recommended Practice No. SNT-TC-1A, NDT Level II

C. The General Contractor shall be responsible for all errors in detailing and fabrication and for correct fitting and attachment of structural members.
   1. The Engineer reserves the right to require each welding operator to use a stamp or mark to identify all work done by that individual.
   2. Welding run-off tabs shall be cut off and ground smooth at the edge of the finished member.
   3. Tack welds which are not incorporated into the final weld shall be removed and ground smooth.
   4. Inadvertent arc strikes shall be removed by grinding

D. All welding shall be 100% visually inspected by the General Contractor and documented on inspection reports. The standard for visual acceptance shall be in accordance with

AWS D1.1. If, based on this standard, the weld is rejected; the entire weld shall be gouged out for a distance equal to the length of the crack plus 2 inches at each end of the crack, and then re-welded, following accepted welding procedures, at the General Contractor ’s expense. Such re-welding is subject to re-inspection.

E. All full penetration welds shall be 100% ultrasonically tested per the static loaded tension weld criteria, Table 6.2, of AWS D1.1, Section 6, Part C, using a SNT-TC-1A Level II Certified nondestructive testing technician. Where shown on the Design Drawings, fillet and partial penetration welds shall be magnetic particle inspected. Also, a minimum of 10% of the remaining welds shall be selected for testing at the discretion of the Engineer. Where magnetic particle testing is impossible due to construction configuration or inaccessibility, dye penetrant inspection may be used with prior written approval of the Engineer. Inspection shall be performed in accordance with AWS D1.1.

F. Reports of weld test results for the nondestructive examination program shall be submitted to the General Contractor for review within twenty four (24) hours after a sequence of testing is completed.

G. Additionally, refer to IBC 2012 Table 1705.2.2 for required continuous and periodic verification and inspection of steel construction.

END OF SECTION

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SECTION 01500

CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Temporary Utilities: Electricity, lighting, heating, ventilating, telephone service, water, and sanitary facilities

B. Temporary Controls: Barriers, enclosures and fencing, protection of the Work, and water control

C. Construction Facilities: Access roads, parking, progress cleaning, storage, and temporary buildings

1.2 GENERAL REQUIREMENTS

A. General Contractor shall furnish, install and maintain all temporary utilities to assure continuous service required for their Work, except as allowed herein, and remove upon completion of Work. Modify and extend systems as work progress requires

B. General Contractor shall furnish, install and maintain all construction aids required for the Work, except as allowed herein, and remove on completion of the Work

C. General Contractor shall furnish, install and maintain fences and barriers only as required for protection of the public, property and their Work. Existing site security fencing and gates can be used.

D. General Contractor may use existing roadways for access and parking to the extent practical.

E. Provide storage sheds as required by the General Contractor

F. Products may be new or used, but must be serviceable, adequate for the intended purpose, and must not violate the requirements of any applicable codes or standards

G. Clean and repair damage caused by temporary installations or use of temporary facilities

H. Provide a project identification sign as stipulated in the Supplementary Conditions

1.3 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies:

1. Comply with applicable Federal and State rules and regulations, local codes and ordinances.
2. Comply with utility company requirements.

1.4 TEMPORARY ELECTRICITY

A. General Contractor shall arrange for and pay all costs associated with power service to the field office and to General Contractor's storage sheds and pay all costs for energy used.

B. Construction equipment larger than 15 amps, 120 volt, single phase, arrange for and pay all costs associated with temporary power service either from the local utility or a portable engine-generator.

C. Equipment testing:
1. Engineer shall pay for energy.
2. General Contractor shall pay all costs for temporary wiring, if required.

D. Provide power outlets for construction operations, with branch wiring and distribution boxes located at the site. Provide flexible power cords as required.

E. Provide main service disconnect and overcurrent protection at convenient location.

F. Permanent convenience receptacles may not be utilized during construction.

G. Provide adequate distribution equipment, wiring, and outlets to provide single phase branch circuits for power and lighting:
1. Provide 20 ampere duplex outlets, single phase circuits for power tools.
2. Provide 20 ampere, single phase branch circuits for lighting.

H. Pay all costs for installation and removal of temporary electrical service

I. General Contractor may use existing receptacle outlets for small power tools with 120V, single phase, 15 amp and grounding connection plugs at no charge for power energy:
1. Use of existing receptacle outlets shall be in such a manner to minimize inconvenience to Engineer and his employees.
2. General Contractor shall provide any required extension cords.
3. Extension cords shall be supported or guarded to positively prevent any hazard of any kind to Engineer's personnel.

1.5 TEMPORARY LIGHTING

A. Provide and maintain incandescent lighting for construction operations.

B. Provide and maintain lighting to exterior staging and storage areas after dark for security purposes as required.

C. Provide branch wiring from power source to distribution boxes with lighting conductors, pigtails, and lamps as required.

D. Maintain lighting and provide routine repairs.

1.6 TEMPORARY HEATING

A. Provide and pay for all temporary heat as required to maintain adequate environmental conditions to facilitate progress of the Work, to meet specified minimum conditions of the installation of materials and to protect materials and finishes from damage due to temperature or humidity.

B. Portable heaters shall be standard approved units complete with controls.

C. Pay all costs of installation, maintenance, operation and removal and for fuel consumed.

1.7 TEMPORARY VENTILATING

A. Ventilate enclosed areas to assist cure of materials, to dissipate humidity, and to prevent accumulation of dust, fumes, vapors, or gases.

B. Provide and pay for temporary ventilation equipment as required to maintain adequate environmental conditions to facilitate progress of the Work, to meet specified minimum conditions for the installation of materials and to protect materials and finishes from damage due to temp or humidity.

C. Provide adequate forced ventilation of enclosed areas for curing of installed materials, to disperse humidity, and to prevent hazardous accumulations of dust, fumes, vapors or gases.

D. Portable ventilators shall be standard approved units complete with controls.

E. Pay all costs of installation, maintenance, operation and removal and for power consumed.

1.8 TELEPHONE SERVICE

A. Provide, maintain and pay for all telephone service to field offices at time of project mobilization.

B. Provide two direct line instruments in Field Office for telephone service:
   1. To field office, one direct line.
   2. To Resident Project Representative field office, one direct line.
   3. Other direct line at General Contractor's option.

C. Pay all costs for removal of telephones.

D. Toll charges shall be paid by the party placing the call.

1.9 TEMPORARY WATER SERVICE

A. Provide all water required for construction purposes.

B. Provide all drinking water required by construction personnel. Pay all costs.

C. There is no existing potable water service to the site.

1.10 TEMPORARY SANITARY FACILITIES

A. Provide sanitary facilities:
   1. Not less than 1 facility for every 20 employees of General Contractor at the site.

B. Service, clean, and maintain facilities and enclosures.

C. Do not permit construction personnel to use Engineer's facilities.

1.11 CONSTRUCTION AIDS

A. Provide construction aids and equipment required by personnel and to facilitate the execution of the Work: Scaffolds staging, ladders, stairs, ramps, runways, platforms, railways, hoists, cranes, chutes, and other such facilities and equipment.

B. General Contractor may, at his own risk, use existing hoists and cranes at the site and hoists and cranes installed hereunder:
   1. Coordinate with Engineer
   2. Do not exceed rated capacity of hoists and cranes
   3. Replace or repair any damaged units
   4. Engineer makes no representation as to the suitability, serviceability, or safety of new or existing hoists and cranes and assumes no responsibility for their safe use by construction personnel.

C. Relocate construction aids as required by progress of construction, by storage or work requirements, and to accommodate legitimate requirements by Engineer.

D. Completely remove temporary materials, equipment, and services at completion of the Project.

E. Clean, repair damage caused by installation or by use of temporary facilities:
   1. Remove foundations and underground installations for construction aids.
   2. Grade the areas for the site affected by temporary installations to required elevations and slopes and clean the area.

1.12 BARRIERS

A. Provide barriers to prevent unauthorized entry to construction areas and to protect existing facilities and adjacent properties from damage from construction operations and demolition.

B. Provide suitable barriers as required for public protection of Engineer’s employees.

C. Protect non-owned vehicular traffic, stored materials, site and structures from damage.

D. Install facilities of a neat and reasonable uniform appearance, structurally adequate for the required purposes.

E. Relocate barriers as required by progress of construction.

F. Completely remove barriers, including foundations, when construction has progressed to the point that they are no longer needed.

G. Clean and repair damage caused by installation, fill and grade the areas of the site to required elevations and slopes and clean the area.

1.13 TEMPORARY FENCING

A. Construction: Commercial grade chain link fence.

B. Provide 6 foot high fence around construction site; equip with vehicular gates with locks.

C. Provide additional fencing to protect stored materials & products or to ensure public safety and the safety of Engineer's employees.

D. Provide Engineer two (2) keys to lock(s).

E. The site of the work is fenced.

1.14 WATER CONTROL

A. Grade site to drain. Maintain excavations free of water. Provide, operate, and maintain dewatering equipment.

B. Protect site from puddling or running water. Provide water barriers as required to protect site from soil erosion.

1.15 EXTERIOR ENCLOSURES

A. Provide temporary insulated weather-tight closure of exterior openings to accommodate acceptable working conditions and protection for Products, to allow for temporary heating and maintenance of required ambient temperatures identified in individual specification Sections, and to prevent entry of unauthorized persons. Provide access doors with self-closing hardware and locks.

B. Provide temporary roofing as required to protect work and equipment.

1.16 EROSION AND SEDIMENT CONTROL

A. Install sediment control fencing, "Mirafi Envirofence", or equal at site perimeter where necessary to prevent erosion and sedimentation from occurring off site.

B. During and after site grading, maintain a roughened surface on all disturbed areas to minimize erosion potential.

C. Construct temporary drainage swales with staked straw bale barriers to control drainage patterns and minimize erosion.

D. Provide gravel and wire or staked hay bale sediment traps at culvert inlets to prevent siltation.

1.17 PROTECTION OF INSTALLED WORK

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

B. Provide temporary and removable protection for installed Products. Control activity in immediate work area to minimize damage.

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

D. Protect finished driving surfaces, floors, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.

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

F. Prohibit traffic from landscaped areas.

1.18 SECURITY

A. Provide security and facilities to protect Work from unauthorized entry, vandalism, or theft.

B. Coordinate with Engineer's security program.

1.19 ACCESS ROADS

A. Extend and relocate as Work progress requires. Provide detours necessary for unimpeded traffic flow.

B. Provide and maintain access to fire hydrants, free of obstructions.

C. Provide means of removing mud from vehicle wheels before entering street or clean streets as required by Engineer.

D. Existing on-site roads may be used for construction traffic.

1.20 PARKING

A. Temporary dirt surface parking areas adjacent to the site can accommodate construction personnel.

B. When site space is not adequate, provide additional off-site parking.

C. Do not allow vehicle parking on existing pavement.

1.21 PROGRESS CLEANING

A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition.

B. Remove debris and rubbish from remote spaces prior to enclosing the space.

C. Remove waste materials, debris, and rubbish from site periodically and dispose off-site in accordance with local and state regulations.

D. Broom and vacuum clean interior areas prior to start of surface finishing.

1.22 FIELD OFFICES AND SHEDS

A. Construction:
   1. Structurally sound, weathertight, with floors raised above ground.
   2. Temperature transmission resistance: Compatible with occupancy and storage requirements.

3. At General Contractor's option, portable or mobile buildings modified for office use may be used.
4. Fill and grade sites for temporary structures to provide surface drainage.
5. Construct temporary field offices and storage sheds on proper foundations, provide connections for utility services:
   a. Secure portable or mobile buildings when used
   b. Provide steps and landings at entrance door
6. Mount thermometer at convenient outside location, not in direct sunlight.
7. Provide periodic maintenance and cleaning for temporary structures, furnishings, equipment and services.
8. Remove temporary field offices, contents, and service at a time they are no longer needed.
9. Remove storage sheds when they are no longer needed.
10. Remove foundations and debris; grade the site to required elevations and clean the areas.

B. Storage Shed:
   1. To requirements of the various trades, as required.
   2. Dimensions: Adequate for storage and handling of products.
   3. Ventilation: Comply with specified and code requirements for the products stored.
   4. Heating: Adequate to maintain temperatures specified in the respective sections for the products stored.

C. Existing facilities at the site shall not be used for General Contractor's field offices or storage.

D. New permanent facilities shall not be used for field offices or for storage.

1.23 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

A. Remove temporary above grade or buried utilities, equipment, facilities, materials, prior to Final Application for Payment.

B. Remove underground installations to a minimum depth of 2 feet. Grade site as indicated.

C. Clean and repair damage caused by installation or use of temporary work.

D. Restore existing facilities used during construction to original condition. Restore permanent facilities used during construction to specified condition.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

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SECTION 01566

WASTE AND SALVAGEABLE MATERIAL

PART 1 GENERAL

1.01 SECTION INCLUDES:

A. This Specification covers disposal of waste material and salvageable material.

B. The General Contractor shall furnish all labor, materials, equipment, and incidentals necessary to dispose of work materials.

1.02 MEASUREMENT AND PAYMENT:

A. No separate payment will be made for work and materials described in this section. Measurement and payment for work and materials described in this section are incidental to the lump sum and/or unit prices shown on the Bid Form.

1.03 SUBMITTALS:

A. Submittals shall conform to requirements of Section 01330 – Shop Drawings, Product Data and Samples.

B. Obtain and submit disposal permits for proposed disposal sites if required by local ordinances.

C. Submit a copy of written permission from Engineer, along with description of property, prior to disposal of excess material adjacent to the Project. Submit a written and signed release from Engineer upon completion of disposal work.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION

3.01 SALVAGEABLE MATERIAL:

A. Salvageable material as determined by the Specifications.

3.02 DISPOSAL OF NON-HAZARDOUS WASTE MATERIALS/SUBSTANCES:

A. The General Contractor shall be responsible for disposing of all non-hazardous material as the term is defined in the Specifications herein, including old concrete or any other non-hazardous material which is required to be removed from the project. Such material shall not be deposited in any sanitary sewer, creek, river, water course or storm sewer system.

3.03 DISPOSAL OF HAZARDOUS MATERIAL/SUBSTANCES:

A. The General Contractor shall be responsible for disposing of all hazardous materials/substances in accordance with all applicable Federal, State and local laws, and in accordance with any specific instructions set out in the plans and specifications herein.

END OF SECTION

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SECTION 01600

COMMON PRODUCT REQUIREMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Applicable general requirements for all materials, equipment and systems specified in the Contract Documents, including Divisions 11 and 13, 14, 15 and 16

B. General Contractor is responsible for ensuring that all mechanical equipment meets requirements of this Section in addition to requirements of individual technical sections

C. Submittals

D. Quality assurance and qualifications

E. Delivery, storage and handling

F. Environmental requirements

G. Warranty

H. Maintenance Materials

I. Equipment identification

J. Equipment, material and fabrication requirements

K. Accessories

L. Lubrication

M. Shop testing

N. Factory testing

O. Preparation, installation and field quality control requirements

1.2 RELATED SECTIONS

A. Section 01330—Shop Drawings, Product Data and Samples

B. Section 01400—Quality Control

C. Section 01630—Product Options and Substitutions

D. Section 01640—Manufacturer's Field Services

E. Section 01730—Operation and Maintenance Data

F. Section 01810—Starting of Systems

1.3 REFERENCES

A. AFBMA Std 9-90—Load Ratings and Fatigue Life for Ball Bearings

B. AFBMA Std 11-90—Load Ratings and Fatigue Life for Roller Bearings

C. AGMA—American Gear Manufacturer Association

D. ANSI B1.1-89—Unified Screw Threads

E. ANSI B1.20.1-83—Pipe Threads, General Purpose (Inch)

F. ANSI B16.1-89—Cast Iron Pipe Flanges and Flanged Fittings, Class 125

G. ANSI B18.2.1-81—Square and Hex Bolts and Screws, Including Askew Head Bolts, Hex Cap Screws, and Log Screws

H. ANSI B18.2.2-87—Square and Hex Nuts

I. Hazardous (Classified) Locations: Conform to requirements of NFPA70 Articles 500 through 504

1.4 GENERAL REQUIREMENTS

A. Section 01600 applies to all equipment provided under this Contract

B. Requirements of technical specifications take precedence over this section in event of apparent conflict

C. Provide all new materials and equipment, except as specified or required by testing

D. General Contractor is responsible for all alterations in the Work to accommodate equipment differing in dimensions or other characteristics from that contemplated in the Drawings or specifications:
   1. Arrangement of equipment shown on the Drawings is based upon information available to Engineer at time of design and is not intended to show exact dimensions peculiar to specific manufacturer
   2. More than one manufacturer may have been used for mechanical layout and design to accommodate all named manufacturer's
   3. Drawings are, in part, diagrammatic, and some features of illustrated equipment installation may require revision to meet actual equipment installation requirements as provided by Supplier
   4. Structural supports and electrical conduit specified may have to be altered during the submittal process to accommodate actual equipment provided by Supplier
   5. No additional payment will be made to General Contractor for such revisions and alterations

E. Provide materials, equipment and/or systems suitable for its intended purpose and/or function as confirmed and supported by the supplier and/or manufacturer where only routine maintenance and care is required for its operation. Do not use material, equipment or a system that will become damaged, require excessive maintenance, fail to perform and not function as required. Materials, equipment and systems provided are expected to function and operate when exposed to the wide range of environmental conditions encountered for this type of facility. Damaged, unsuitable or defective materials, equipment and/or systems identified by the Engineer shall be replaced at no additional cost.

F. Equipment lists presented in these specifications and as specified on the Drawings are included for convenience of Engineer are not to be considered as complete listings of all equipment, devices and material to be provided under this contract:
   1. General Contractor shall prepare his own material and equipment take-off lists as necessary based on the Contract Documents to meet requirements of this project

G. Failure to complete this requirement shall be considered as a General Contractor caused delay and any time lost from the schedule shall not be considered as a reason for extension of Contract Time

H. Nothing in this provision shall be construed as relieving General Contractor of the terms and conditions of the Contract

1.5 SUBMITTALS

A. Provide submittals in accordance with Section 01330

B. Compile and submit all submittals for each component of multi-component systems through General Contractor to Engineer by manufacturer having system responsibility

C. Provide copy of this specification section with all addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.

D. Supplier’s certified data showing location of critical speeds in relation to operating speeds

E. Vibration isolation systems (if applicable):
   1. Submit for reference purposes:
      a. Include design reports with equipment product data
      b. Design Engineer’s qualifications
      c. Calculations showing static and dynamic deflections, weights, isolator locations, and flexible connector designs
      d. Indicate types, styles, materials and finishes for each type of isolator specified
      e. Spring deflections and diameters, compressed spring heights
      f. Curb mounted base seal and wind resistance details
      g. Scale drawing of mounting hanger with 30-degree arc capability
      h. Seismic restraint load deflection curves up to 1/2-inch deflection along three principal orthogonal axis

F. Inverter duty motors (if applicable): Include motor manufacturer's certification that motor is compatible with variable frequency controllers to be used with motor

1.6 DEFINITIONS

A. Special tools, instruments, devices, or accessories: Any tools, instruments, devices or accessories required for repair, adjustment or maintenance of equipment which are designed especially for specified equipment or which are not normally kept in stock by local tool suppliers

B. Responsible manufacturer: Unless specified otherwise, responsible manufacturer shall be manufacturer of driven equipment. Agents, representatives or other entities who are not a direct component of manufacturing corporation will not be acceptable as a substitute for manufacturer's corporation in meeting this requirement

1.7 DELIVERY AND HANDLING

A. Arrange deliveries of products in accord with construction schedules.

B. Deliver products in undamaged condition, in Supplier's sealed, weather tight, original container or packaging, with identifying labels intact and legible, all in accordance with manufacturer's instructions:
   1. Protect from exposure to highway and weather elements
   2. Keep thoroughly dry at all times
   3. Box, crate or provide other adequate means of support to protect against damaging stresses during transport and unloading and to facilitate proper handling
   4. Apply grease and lubricating oil to all bearings and similar items for shipping
   5. Wrap or seal bearing housings to prevent contamination from grit and dirt
   6. Tape closed ventilation and other types of openings

C. Use stiffeners where necessary to maintain shapes and to provide rigidity

D. Protect painted surfaces against impact, abrasion, discoloration or other damage

E. Include complete packing lists and bills of material with each shipment including Equipment Identification number assigned by the Contract Documents

F. Deliver anchor bolts together with templates

1.8 ENVIRONMENTAL REQUIREMENTS

A. Project is a treatment facility where concentrations of corrosive chemicals are used and other various chemicals expected to be present

B. Various corrosive or explosive mixtures of liquids including; solvents, grease, gasoline and other hazardous materials may enter the plant with the incoming water

C. Minimum Design Criteria:
   1. Altitude: 1,300± ft above mean sea level
   2. Outdoor air temperature: 0 to 120 degrees F
   3. Wind speed: 90 mph
   4. IBC Exposure Category: B
   5. Seismic Design:
      a. Seismic Site Class D* per the International Building Code Table 1613.5.2. *A Site Class D classification assumes that a stiff soil profile is present onsite and that Standard Penetration Test N-values for the top 100 feet average between 15 and 50 blow-counts. This classification will be verified with a geotechnical investigation performed onsite.

   6. Annual Rainfall: 5.7 inches.

1.9 WARRANTY

A. Warranty all materials and equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, leakage, breakage or other failure

B. Unless specified otherwise, for all materials and equipment provide manufacturer's warranty for a period of 1 year from the date of Substantial Completion as defined under Contract Agreement

C. Warranties that begin at the time of shipment, delivery or within a limited time period from date of shipment or delivery or any other qualification that does not conform to the definition of Substantial Completion are not acceptable

D. Cost of all manufacturer warranties are considered as part of the Bid price

1.10 MAINTENANCE MATERIALS

A. Spare Parts:
   1. Store spare parts, wherever required by technical specifications, in accordance with the provisions of this paragraph
   2. Tag all spare parts with permanent, labeled packings by equipment designation number and identified as to part number, equipment manufacturer, and subassembly component (if appropriate)
   3. Properly protect spare parts subject to deterioration such as ferrous metal items and electrical components with lubricants or desiccants and encapsulate in hermetically sealed plastic wrapping
   4. Store spare parts with individual weights less than 50 pounds and dimensions less than 2 feet wide, or 18 inches high, or 3 feet in length in wooden box:
      a. Provide box with hinged wooden cover and locking hasp
      b. Hinges: Strap type
      c. Paint box and identify with stenciled lettering stating name of equipment, equipment numbers, and words "spare parts"
   5. Prepare and provide neatly typed inventory of spare parts inserted in watertight plastic sleeve and taped to underside of box cover

1.11 IDENTIFICATION

A. Nametags: Identify all valves, instruments, devices, materials with equipment tag designation numbers and prefix and suffix letters as specified and/or shown on Process and Instrumentation Drawings (P&IDs).

B. Nameplates: Identify all pumps and equipment with equipment tag designation numbers and prefix and suffix letters as specified and/or shown on Process and Instrumentation Drawings (P&IDs):
   1. Engraved or machine stamped non-corrosive nameplate fastened to pump or equipment base plate with screws or drive pins: White with black letters/numbers.
   2. Nameplate material shall not corrode or discolor in moist atmosphere or chemical spray
   3. Nameplates to indicate following:
      a. Manufacturer
      b. Date of manufacture
      c. Model and size
      d. Serial Number
      e. Rating in gpm or ACFM (if a fan or blower) and feet of head or inches water column
      f. Impeller or wheel diameter (if a fan)
      g. Impeller diameter
   4. Motor Nameplates:
      a. Identify all motors for pumps and other equipment as specified elsewhere under this Section

1.12 FABRICATION

A. Design, fabricate, and assemble in accordance with best modern manufacturing and shop practices

B. Manufacture parts to standard sizes and gages

C. Two or more items of the same type: Identical by same manufacturer and interchangeable

1.13 CONTROL PANELS

A. All electrical control panels specified in the Contract Documents, including Divisions 11, 13, 14, 15 and 16.

1.14 ACCESSORIES

A. Equipment base for pumps and equipment:
   1. Provide concrete base for all equipment and support legs as shown on Drawings, unless specified otherwise
   2. Mounting of base plates or support legs directly on concrete floor will not be acceptable
   3. Dowel all equipment bases directly into existing concrete floor slab as shown on Drawings

4. Cast equipment and pump anchor bolts directly in concrete base using manufacturer provided templates:
    a. Expansion anchors drilled into bases after pouring concrete are not acceptable
5. Coordinate height and horizontal dimensions of bases to set equipment at proper elevations for connections shown on Drawings and to provide minimum over-hang beyond base plate or support legs:
    a. Concrete base configuration: Follow same outline of equipment base plate to allow for easy access to equipment components for operation and maintenance
    b. "Squaring off" base for equipment bases that are not square is not acceptable unless specifically authorized by Engineer in writing

B. Base plates:
1. Mount all equipment, gear boxes and drivers on a common cast iron or fabricated steel base plate, unless specified otherwise
2. Factory mount all equipment to base plate
3. Mount all base plates on concrete base where required
4. Cast iron or welded steel
5. Provide for pumps, compressors and similar equipment
6. Neat design
7. Concrete equipment base for anchoring
8. Adequate grout holes
9. Provide pump base plates with raised lip or other acceptable means for collecting leakage
10. Provide raised lip or drain pans with threaded drain connection and plug
11. Pipe all base drains to nearest floor or trench drain using pipe specified
12. Reference requirements for V-belt drives for additional base plate requirements

C. Pump and equipment shaft seals:
1. Seals for water and wastewater pump and equipment shafts: Mechanical seals or stuffing boxes
2. Conform to requirements set forth in this paragraph, unless specified otherwise
3. Where mechanical seals are specified:
    a. Nondestructive (nonfretting) type that requires no wearing sleeve for shaft
    b. Shafts for pumps specified with mechanical seals: Furnish with no reduction in size through seal area
    c. Cartridge type, requiring no field assembly, other than insertion into pump
    d. Metal parts: Type 316 or 316L stainless steel
    e. Springs: Hastelloy C
    f. Rotary faces: Tungsten carbide or silicon carbide
    g. Stationary faces: Ceramic, tungsten carbide, or silicon carbide

4. Mechanical seals for constant speed, overhung shaft pumps including split case and centrifugal pumps: Self-aligning, single, rotary type, Chesterton 123, Crane 88 S, or approved equal
5. Mechanical seals for variable speed, overhung shaft pumps: Double, balanced, self-aligning type, Crane 88 D, Chesterton 222 or 241, or approved equal
6. Boxes for mechanical seals on pumps for contaminated water service (sludge, grit, wastewater, scum, reclaimed water, etc.): Drilled and tapped for installation of clean water barrier fluid supply piping

D. Couplings:
1. Equipment with driver greater than 1/2 Hp and where input shaft of driven unit is directly connected to output shaft of driver: Connect its two shafts by flexible coupling which can accommodate angular misalignment, parallel misalignment and end float, and which cushions shock loads and dampens torsional vibrations, unless specified otherwise
2. Flexible member consists of tire with synthetic tension members bonded together in rubber
3. Attach flexible member to flanges by means of clamping rings and cap screws with flanges attached to stub shaft by means of tapelock bushings which give equivalent of a shrunk-on fit
4. No metal to metal contact between driver and driven unit
5. Provide and size each coupling as recommended by coupling manufacturer for specific application, considering horsepower, speed of rotation and type of service
6. Where torque or horsepower capacities of couplings specified above are exceeded provided they are sized in accordance with equipment manufacturer's recommendations and sizing data are submitted, Thomas-Rex, Falk Steel Flex or approved equal

E. Gage taps, test plugs and gages:
1. Provide pressure gage taps on suction and discharge sides of pumps, blowers and compressors
2. Provide pressure and vacuum gages where specified
3. Gages and test plugs as specified in Divisions 13 and 15 respectively

F. Guards:
1. Provide exposed moving parts with guards which meet requirements of OSHA
2. Fabricated of 14-gage steel, 1/2-13-15 expanded metal screen to provide visual inspection of moving parts without removal of guard
3. Galvanize all guards after fabrication
4. Design to be readily removable to facilitate maintenance of moving parts
5. Provide reinforced holes at openings
6. Extend lubrication fittings through guards

G. Special tools and accessories:
   1. Provide all special tools, instruments and accessories required for proper maintenance
   2. Provide all special lifting and handling devices required

H. Lifting handles:
   1. Provide lifting handles, lugs or eye bolts on all individual components of equipment systems weighing 50 pounds or more

1.15 LUBRICATION

A. Provide sufficient supply of lubricant required for start-up and demonstration period

B. Lubricant: Type recommended by equipment manufacturer and be products of Engineer's current lubrication supplier to extent practical

C. Limit various types of lubricants by consolidating them into least number of different types with manufacturers' approvals

D. Provide Engineer with three copies of list showing required lubricants after consolidation for each item of mechanical equipment not less than 90 days prior to scheduled date shown in construction schedule for starting, testing and adjusting equipment:
   1. Show estimated quantity of lubricant needed for full year's operation of each piece of equipment assuming equipment will be operated continuously

E. Check and refill all lubricant levels after demonstration period

F. Lubrication System:
   1. Require no more than weekly attention during continuous operation
   2. Require no attention during equipment startup and shutdown
   3. No lubricant wasting
   4. Convenient and accessible:
      a. Oil drains and fill plugs easily accessible from normal operating area or platform
      b. Drains located to allow convenient collection of oil during oil changes without removing equipment from its normal installed position
   5. Provide constant level oilers or oil level indicators for oil lubrication systems

1.16 VIBRATION AND CRITICAL SPEED LIMITATIONS

A. Take field tests and vibration measurements when specified

B. Vibration frequencies span: Range from 5.0 to 5,000 Hz

C. Where specified, take measurements while installed equipment is operating within specified speed range

D. Centrifugal:
   1. Machines with sleeve bearings:
      a. Unless specified otherwise, centrifugal machines with sleeve bearings shall not exhibit unfiltered RMS readings for vibration displacement in excess of the following:

Shaft Speed, rpm	Displacement, peak to peak, mils
Up to 900	3.5
901-1,800	3.0
1,801-3,000	2.5
3,001-4,500	2.0
Above 4,500	1.6

      b. Take displacement measurements radially on shaft at two points at each bearing:
         1) Measuring points taken 90 degrees apart
   2. Machines with antifriction bearings:
      a. Unless specified otherwise, centrifugal machines with antifriction bearings shall not exhibit unfiltered RMS readings for vibration velocity in excess of 0.12 inch per second
      b. Take velocity measurements on one point of each bearing housing

E. Positive displacement machines:
   1. Unless specified otherwise, positive displacement machines of the rotary, reciprocating and controlled volume types shall operate without any lateral or torsional vibration characteristics that may accelerate wear
   2. Manufacturer's certification: Certify that manufacturer has inspected machine under operating conditions and found it to comply with requirements of this paragraph

F. Critical speed requirements:
   1. Unless specified otherwise, rotating mechanical equipment shall not exhibit critical speeds within specified range of operating speeds
   2. Critical speeds for equipment with rigid motor systems: 20 percent greater than maximum operating speed
   3. Critical speeds for equipment with flexible shaft-rotor systems: 15 percent below minimum operating speed and 20 percent above maximum operating speed

1.17 MASS ELASTIC SYSTEMS AND CRITICAL SPEEDS

A. Provide pumping units consisting of pump, shafting, couplings, motor, variable frequency driver and all attached appurtenances with no dangerous critical or resonant frequencies or multiples of resonant frequencies within 20 percent above and 35 percent below speed range required by pump to meet specified operating conditions

B. Dangerous critical speed: Defined as speed that produces torsional stress exceeding 3,500 psi

C. Provide analysis of critical speeds and complete mass elastic system: Analysis and certification by registered Professional Engineer regularly engaged in this type of work

D. The analysis shall particularly address resonant frequencies induced by the operation of the proposed variable frequency speed control system

E. Analysis to be based upon techniques developed by Dunkerly and Holzer

1.18 QUALIFICATIONS

A. Installers qualifications:
   1. Equipment and material: Installed and placed in service by or under guidance of qualified personnel having knowledge and experience necessary for proper results
   2. Where General Contractor's employees are not properly qualified, use personnel such as factory authorized field representative of supplier

1.19 QUALITY ASURANCE

A. Source Quality Control and Tests:
   1. Observation of performance tests:
      a. Where specifications require presence of Engineer for testing of equipment, Engineer shall arrange for the first visit
      b. If subsequent visits by Engineer are required because of incomplete tests, retesting or subsequent tests, General Contractor shall reimburse Engineer for all costs
   2. Balancing:
      a. Where specified, submit balancing reports as product data, demonstrating compliance with this requirement
      b. Unless specified otherwise, fully assemble all rotating elements in motors, pumps, blowers and centrifugal compressors including coupling hubs, before being statically and dynamically balanced:
         1) Balance all rotating elements to the following criteria:

$$e = 16 \frac{W}{N}$$

Where:
e = imbalance, ounce-inches, maximum
W = Weight of the balanced assembly, pounds mass
N = Maximum operational speed, rpm

B. Factory assembly and testing:
   1. Factory assemble and test equipment and pumps before being shipped to job-site
   2. Ship units assembled for installation by General Contractor unless shipping limitations or special installation requirements dictate otherwise:
      a. If knocked down, ship equipment in minimum practical number of pieces for field assembly by General Contractor
   3. Subject each pump to non-witnessed test at full speed using calibrated motor:
      a. Comprehensive test to develop head, capacity and efficiency for at least 6 points on pump's head/capacity curve and shall confirm performance at guaranteed performance condition (rated condition)
   4. Conduct all tests in accordance with test code of standards of the Hydraulic Institute except that predicted performance from model tests will not be accepted
   5. Test results shall be signed and certified correct under penalty of perjury by an officer of manufacturing corporation
   6. Upon completion of testing, produce curves showing pump performance at full speed and predicted performance at speeds required to meet all other specified operating conditions
   7. Do not ship or deliver pumps until certified tests have been submitted and reviewed by Engineer
   8. Final acceptance of equipment will depend on satisfactory operation after installation in the Work

PART 2 PRODUCTS

2.1 MATERIALS

A. Suitable for the intended service conditions

B. Structural and miscellaneous fabricated steel in equipment: Conform to AISC standards, except as specified otherwise

2.2 ELECTRIC MOTORS

A. Designed and applied in accordance with NEMA, ANSI, IEEE, AFBMA, and NEC standards for duty imposed by driven equipment

B. Manufacturer's:
   1. Reliance Electric
   2. U.S. Motor

3. Baldor
4. No substitutions

C. If driven equipment is subject to frequent starting duty, provide motors suitable for that duty

D. Nameplate horsepower based on continuous duty at 40 degrees C ambient, unless recognized and defined by the standards and codes for intermittent duty as a standard industry practice. Temperature rise about 40 degrees C ambient on continuous operation not to exceed the NEMA limit for 1.0 service factor and Class B insulation or Class A insulation if used

E. Designed for satisfactory operation at any voltage within plus or minus 10 percent of rated voltage

F. Designed for full voltage starting, unless specially noted otherwise in Contract Documents

G. Bearing life based on actual operating load conditions imposed by driven equipment

H. Derated for altitude at which equipment is installed

I. Nameplate horsepower sized for continuous operation is 40 degrees C ambient at least 15 percent more than the max continuous load imposed by the driven equipment, if service factor is 1.0, unless specifically noted otherwise in Contract Documents

J. If driven equipment specification calls for encapsulated winding:
1. Provide sealed insulation system designed for more severe environment than usual varnish treatments can withstand
2. Motors with encapsulated windings may be single voltage rated
3. U. S. Motors “Ever-seal” or approved equal

K. Clamp-type grounding terminal inside motor conduit box, twist type are not acceptable

L. Oversized motor conduit boxes, with 3/4 inch NPT minimum unless indicated otherwise

M. Totally enclosed for all indoor process area applications

N. Dripproof or totally enclosed outdoors, suppliers option unless specified otherwise

O. On integrally constructed motor driven equipment:
1. Appliances and hand tools and similar equipment, specified by model number
2. Manufacturer's standard motor may be provided if complete redesign of unit would be required to meet requirements of this article

P. Motors to be powered by variable frequency controllers:
   1. "Inverter duty" type motor insulation systems
   2. Conform to NEMA MG1 31.40.4.2 standards for resistance to spikes of 1,600 volts with 0.1 microsecond rise time
   3. Permanent nameplate: Denote that the motor is rated for inverter duty

Q. Below 1/2 hp:
   1. 115 V, 60 Hz
   2. Single phase
   3. Squirrel cage
   4. Capacitor start
   5. Induction run type
   6. Copper windings
   7. Class B insulation
   8. 1.15 Service Factor
   9. Continuous time rated in conformance with NEMA Standard MG 1, paragraph 10.35
   10. Stainless steel hardware
   11. Permanently lubricated sealed bearings
   12. Built-in, manual-reset thermal protector or provided with an integrally mounted manual motor starter, NEMA 1 enclosed indoors, NEMA 4 enclosed outdoors. No automatic reset overload devices
   13. Overload devices which reset automatically are unacceptable

R. 1/2 to 1 hp:
   1. 230/460 V, 60 Hz, 3 phase
   2. All internal surfaces coated with an epoxy paint
   3. Stainless steel hardware
   4. Specially insulated for damp locations below 20 degrees C
   5. Oil or grease lubricated antifriction or oil lubricated sleeve bearings
   6. 15 yr average life thrust bearings in vertical motors

S. 1-1/2 hp and above:
   1. 230/460 V, 60 Hz, 3 phase
   2. Aluminum frame motors will not be allowed
   3. Cast iron frames
   4. Cast metal fan blades and shrouds
   5. All internal surfaces coated with an epoxy paint
   6. Full voltage start induction type
   7. NEMA MG 1-1.16 design letter B or C torque characteristic as required by the driven equipment's starting torque requirements
   8. Stainless steel hardware
   9. Nonhydroscopic leads

10. Specially insulated for damp locations below 20 degrees C
11. Oil or grease-lubricated anti-friction or oil- lubricated sleeve bearings
12. 15 yr average life thrust bearings in vertical motors
13. Minimum motor efficiencies unless specified otherwise:
    a. Motor efficiencies determined in accordance with IEEE 112, Method B, as adopted by NEMA

FOR PREMIUM EFFICIENCY MOTORS

hp	efficiency
1	83
1.5	83
2	83
3	86
5	87
7.5	88
10	89
15	90
20	90.5
25	91.5
30	92
40	92.5
50	93

FOR PREMIUM EFFICIENCY MOTORS

hp	efficiency
60	93
75	93.5
100	94
125	94
150	94.5
200 and above	94.5

T. Motor testing requirements:
    1. Short commercial test for standard or high efficiency motor for motor horsepower less than 50 hp
    2. Motor test results for complete test on one of each size motor for motor horsepower 50 hp or greater:
        a. Current balance
        b. High potential test
        c. Vibration test
        d. Winding resistance
        e. Locked rotor current
        f. No load running current

g. Full load heat run
h. Full load percent slip
i. Efficiency at 100 percent, 75 percent, and 50 percent load
j. Power factor at 100 percent, 75 percent, and 50 percent load

3. Submit test results under provisions of Section 01330

2.3 FLANGES AND PIPE THREADS

A. Flanges on equipment and appurtenances: ANSI B16.1, Class 125

B. Pipe threads: ANSI B1.1, coarse thread series, Class 2 fit

C. Threaded flanges:
1. Standard taper pipe thread, ANSI B1.20.1
2. Flat faced, unless specified otherwise

D. Flange assembly bolts:
1. Heavy pattern, hexagonal head, carbon steel machine bolts
2. Nuts: Heavy pattern, hot pressed, hexagonal, ANSI B18.2.1 and B18.2.2
3. Threads: Unified screw threads, standard coarse thread series, Class 2A and 2B, ANSI B1.1

2.4 BEARINGS

A. Equipment bearings:
1. Oil or grease lubricated, ball or roller type, designed to withstand stresses of service specified
2. Each bearing rated in accordance with latest revisions of AFBMA Methods of Evaluating Load Ratings of Ball and Roller Bearings
3. Minimum L-10 rating life: 50,000 hours
4. Rating life: Determined using maximum equipment operating speed
5. Unless specified otherwise

B. Grease lubricated bearings, except those specified to be factory sealed and lubricated:
1. Fitted with easily accessible grease supply, flush, drain and relief fittings
2. Use extension tubes when necessary
3. Grease supply fittings: Standard hydraulic alemite type

C. Oil lubricated bearings with either pressure lubricating system or separate oil reservoir type system:
1. Each oil lubrication system of sufficient size to safely absorb heat energy normally generated in bearing under maximum ambient temperature of 60 degrees C
2. Equipped with filler pipe and external level indicator gage

D. Incorporate bearing housings with sufficient cooling to maintain surface temperature at 65 degrees C or less for continuous operation at bearing rated load and 50 degrees C ambient temperature or provide appropriate shielding that will prevent inadvertent human contact for all bearings accessible to touch and located within 7 feet, measured vertically from floor or working level, or within 15 inches measured horizontally from stairways, ramps, fixed ladders or other access structures

2.5 V-BELT ASSEMBLIES

A. V-belt assemblies:
   1. Dodge Dyna-V belts with matching Dyna-V sheaves and Dodge Taper-Lock bushings, Wood's Ultra V-belts with matching Ultra-V sheaves and Wood's Sure-Grip bushing, unless specified otherwise
   2. Or approved equal

B. Statically balance sheaves and bushings

C. Dynamically balance sheaves and bushings which operate at peripheral speed of more than 5,500 feet per minute

D. Separately mount sheaves on their bushings by means of three pull-up grub or cap tightening screws

E. Key seat bushings to drive shaft

F. Select belts for not less than 150 percent of rated driver horsepower

G. Where two sheaves sizes are specified they shall be capable of operating with either set of sheaves

H. Belt speeds:
   1. Size sheaves for 1:1 reduction ratio based on driver speed, unless specified otherwise
   2. Maximum speed reduction ratio for V-belt where constant speed reduction is specified: 4:1

I. Belts to be antistatic type where explosion proof equipment is specified

J. Base plate mount:
   1. Provide slide adjustment designed to allow tightening belts and alignment adjustments

K. Adjustable speed belt drives:
   1. Maximum speed reduction: 4:1

2. Speed adjustable without shutting off equipment

2.6 GEAR DRIVES

A. Designed in accordance with AGMA 460.05, Class II or AGMA 420.04:
   1. Minimum service factor: 1.25
   2. Maximum turn down: 5.95:1
   3. Anti-reversal holdback: When gear box is direct connected by drive shaft to pump, incorporate holdback in gear box

2.7 ANTI-REVERSAL HOLDBACK

A. Provide all pumps with anti-reversal holdback designed to prevent reversal of flow when pump is not operating:
   1. Differential friction type acts directly on pump shaft
   2. Sized by manufacturer having system responsibility for specified service
   3. Where gear box is specified for pumps refer to gear box requirements

2.8 VIBRATION ISOLATION SYSTEMS

A. Provide vibration isolation systems in accordance the requirements of this Section unless specified otherwise

B. Design vibration isolation systems including isolators, seismic restraints and flexible connectors between isolated equipment and associated piping, ducting or electrical work by a Professional Engineer qualified in this type of design.

C. Use Table 7 as specified in ASHRAE CH-52, Handbook, HVAC Systems and Applications, Sound and Vibration Control, latest edition

D. Provide flexible connectors to any appurtenances of equipment by responsible manufacturer in accordance with isolation system engineer

E. Submittal: Stamped copies of professional design report of vibration system design, including base and associated piping with Professional Engineer's seal and signature. This report will not be subject to review by Engineer as a submittal, it is intended for Engineer files for documentation purposes

F. Use rigid steel bases. Cast iron equipment bases are not acceptable for equipment requiring vibration isolation systems

G. Vibration isolation system manufacturer's:
   1. Pumps and equipment:
      a. Mason Industries, Inc.

b. Korfund Dynamics Corporation
c. Consolidated Kinetics Corporation
d. Or approved equal

2. HVAC Equipment:
a. Kinetics Noise Control
b. Korfund Dynamics Corp
c. Mason Industries, Inc
d. Or approved equal

H. Curb mounted equipment for roof top heating, ventilating and air conditioning:
1. Vibration isolation bases: Fit over curb and under isolated equipment
2. Weather seal: Closed cell materials both above and below base, foam and other contact materials are not acceptable at spring (isolator) cavity closure area, caulking kept to a minimum
3. Connection duct: Weatherproof flexible neoprene

I. Refer to equipment schedules for type of isolators required

J. Mountings:
1. Specification "A" - Double deflection neoprene mountings:
a. Minimum static deflection of 0.35 inch
b. All metal surfaces: Neoprene covered to avoid corrosion with friction pads both top and bottom so they need not be bolted to floor
c. Bolt holes: Provided for areas where bolting is required
d. On equipment such as small vent sets and close coupled pumps: Steel rails used above mounting to compensate for overhang
e. Mason type ND or rails type DNR or accepted substitution
2. Specification "B" - Spring-type isolators:
a. Free-standing and laterally stable without any housing, complete with 1/4 inch neoprene acoustical friction pads between baseplate and support
b. All mountings: Leveling bolts that must be rigidly bolted to equipment
c. Spring diameters: No less than 0.8 of compressed height of spring at rated load
d. Springs: Minimum additional travel to solid equal to 50 percent of rated deflection
e. Submittals: Include spring diameters, deflections, compressed spring height and solid spring height
f. Mason type SLF or accepted substitution

K. Hangers:
1. Specification "D" - Vibration hangers:
a. Contain steel spring and 0.3 inch deflection neoprene element in series

b. Neoprene element: Molded with rod isolation bushing that passes through hanger box
c. Spring diameters and hanger box lower hole sizes: Large enough to permit hanger rod to swing through 30-degree arc before contacting hole and short-circuiting spring
d. Springs: Minimum additional travel to solid equal to 50 percent of rated deflection
e. Submittals: Include scale drawing of hanger showing 30-degree capability
f. Mason Type 30N or accepted substitution

L. Flexible pipe connectors:
1. Specification "P" - Flexible connectors 1/2 inch through 1-1/2 inch:
a. Wire and fabric reinforced Butyl hose rated for 150 psi at 240 degrees F
b. Fittings: Brass screw-type attached by an expansion or swaging method
c. Overall lengths: Not less than 12 inches
d. Hoses: Metraflex Elasto-flex connector or accepted substitution
2. Specification "Q" - Flexible connections 2 inches through 12 inches:
a. Neoprene twin-sphere type units complete with 150 lb-ASA steel floating flanges
b. Design pressure: 150 psi at 230 degrees F
c. Allowable movement limits: 7/8 inch axial compression minimum, 1/2 inch axial elongation, 7/8 inch lateral movement, and 30-degree angular movement
d. Connections: Mason type MFTNC, Metraflex Metasphere, General Rubber, or Streamflo

2.9 ANCHOR BOLTS

A. Provide and design anchor bolts for all equipment and pumps for lateral forces for both pullout and shear in accordance with provisions of these Specifications unless stated otherwise in the Contract Documents:
1. Furnished with equipment by responsible equipment manufacturer
2. Bolt templates provided by the manufacturer at time of equipment delivery to project site
3. Provide minimum of 2 nuts per bolt
4. Minimum diameter: In accordance with Part 3 of this Section
5. Long enough to permit 1-1/2 inch of grout below base plate, if equipment is baseplate mounted, and to provide minimum anchorage into structural concrete

2.10 PROTECTION AGAINST ELECTROLYSIS

A. Provide suitable insulation between dissimilar metals where used in conjunction with each other between adjoining surfaces so as to eliminate direct contact and any resultant electrolysis

B. Provide bituminous impregnated felt, heavy bituminous coatings, nonmetallic separators or washers or other materials acceptable to Engineer

2.11 FACTORY APPLIED COATINGS

A. Ship each item of equipment to site with shop applied prime coating. Prime coating shall serve as a base for the field-applied finish coats

B. Apply prime coating over clean dry surfaces in accordance with paint manufacturer's recommendations:
   1. Provide adequate final cure in accordance with the coating manufacturer's recommendations of all coatings before shipping

C. Supplier responsible to ensure prime coat used is compatible with acceptable finish coats specified

D. Supplier shall be prepared to certify and guarantee compatibility of primer coats used with finish coats specified

E. Paint for self-contained or enclosed components such as motors, speed reducers and starters: Manufacturer's standard

F. Coat all steel and iron surfaces

G. Protect surfaces which will be inaccessible after assembly for life of equipment

H. Provide smooth uniform base for painting of exposed surfaces by finishing smooth, cleaning thoroughly, and filling as necessary

I. Apply shop primer to protect equipment to be field painted

J. Shop finish self-contained or enclosed components

2.12 FINISHING

A. Finish paint, label and stencil all pipes, valves, ducts, equipment and equipment base plates for protection and identification

B. Protect all equipment nameplates during painting

PART 3 EXECUTION

3.1 SHOP TESTS

A. Perform equipment and pump shop testing under provisions of individual technical specifications and Section 01400

3.2 FIELD TESTS

A. Perform equipment and pump testing under provisions of individual technical specifications and this Section

B. Pumps:
   1. After manufacturer installation check and pre-start-up, during pre-demonstration period, test all pumps in field to confirm performance criteria as specified
   2. Perform tests to confirm performance points on pump curves as specified for flow rate and pressure: Provide temporary instruments, gauges or other methods acceptable to the Engineer
   3. Test results to be measured with sufficient accuracy to satisfy test criteria in accordance with Hydraulic Standards Institute
   4. Test results must comply within deviations set by Hydraulic Standards Institute for performance acceptability
   5. Replace pumps and/or impellers that fail to satisfy specified performance

C. Process equipment:
   1. After manufacturer installation check and pre-start-up, during the pre-demonstration period, test all equipment in field to confirm performance criteria as specified

D. Test all instruments while equipment is operating during pre-demonstration period

3.3 FIELD QUALITY CONTROL

A. Supplier shall provide qualified field representative for services as specified in Sections 01400 and 01640.

B. Where installation assistance is specified, manufacturer’s field representative is to observe, guide, instruct and direct General Contractor's erection or installation procedure

C. Where an installation check is specified, manufacturer’s field representative is to verify equipment is properly installed as detailed in Sections 01400 and 01640.

D. Field representatives are to revisit site as often as necessary to attain installation satisfactory to Engineer

3.4 ADJUSTING

A. Supplier shall assist General Contractor to perform all required adjustment tests, operation checks, and other startup activities required

END OF SECTION

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SECTION 01630

PRODUCT OPTIONS AND SUBSTITUTIONS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Product options available to General Contractor

B. Procedures for securing acceptance of proposed Substitutions for a product which is specified in Contract Documents by reference to one or more of the following:
   1. Name of manufacturer
   2. Name of General Contractor
   3. Trade name
   4. Catalog model number

1.2 RELATED SECTIONS

A. Section 01330—Shop Drawings, Product Data, and Samples

B. Divisions 11 & 13 – Equipment Specifications

1.3 GENERAL REQUIREMENTS

A. The Contract is based on standards of quality established in Contract Documents:
   1. In agreeing to terms and conditions of Contract, General Contractor has accepted a responsibility to verify that specified products will be available and to place orders for all required materials in such a timely manner as is needed to meet construction schedule
   2. Engineer has not agreed to substitution of materials or products called for in Contract Documents, except as they may specifically be stated otherwise in writing

1.4 PRODUCT OPTIONS

A. Products Specified by Reference Standards or by Description Only—Any Product meeting those standards or description:
   1. Products specified by reference to standard specifications such as ASTM and similar standards
   2. Products specified by manufacturer’s name and catalog model number

B. Products Specified by Naming One or More Manufacturers—Products of manufacturers named and meeting specifications, no options or substitutions allowed:
   1. Where materials and/or products are specified by naming one single manufacturer and/or model number, without stating that Substitutions will be considered, only the material and/or products named are approved for incorporation into the Work

C. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions—Submit a request for substitution for any manufacturer not named in accordance with this section:
   1. Where materials and/or products are specified by name and/or model number, followed by words "Or accepted substitution":
      a. The material and/or product specified by name establishes required standard of quality
      b. Materials and/or product proposed by General Contractor to be used in lieu of materials and/or products so specified by name shall in all ways equal or exceed the qualities of named materials and/or products

D. Where phrase "or accepted substitution" occurs in contract documents, do not assume that materials, equipment or products will be accepted as substitution unless item has been specifically so reviewed for this Work by Engineer.

1.5 SUBSTITUTIONS

A. Engineer will consider requests for Substitutions only within 15 days after date of General Contractor - Engineer Agreement

B. Written requests for substitution considered:
   1. After award of Contract
   2. Only when submitted through General Contractor.

C. Substitutions will not be considered when they are indicated or implied on shop Drawing or product data submissions, without separate written request

D. Substitutions may be considered when a Product becomes unavailable through no fault of General Contractor :
   1. Should the General Contractor demonstrate that specified material or product was ordered in a timely manner and will not be available in time for incorporation into this Work, General Contractor shall submit to Construction Manger such data on proposed substitute materials and/or product as are needed to help Engineer determine suitability of proposed Substitution

E. Document each request with complete data substantiating compliance of proposed Substitution with Contract Documents

F. A request constitutes a representation that General Contractor :
   1. Investigated proposed product and determined that it meets or exceeds quality level of specified product and that it will perform function for which it is intended
   2. Will provide same warranty for Substitution as for specified Product
   3. Will coordinate installation and make changes to other Work which may be required for Work to be complete with no additional cost to Engineer
   4. Will provide a complete operating installation including any and all changes and additions in structure, piping, building, mechanical and electrical work, controls and accessories necessary to accommodate proposed Substitution
   5. Waives claims for additional costs or time extension which may subsequently become apparent
   6. Will reimburse Engineer for review or redesign services associated with re-approval by authorities.

1.6 PROCEDURE FOR REQUESTING SUBSTITUTION

A. Submit three copies of request for substitution for consideration in a manner similar to provisions for submission requirements under Section 01330:
   1. Substitutions will be considered as "deviations" to the Contract Documents
   2. Submit with transmittal letter describing the deviation and justifications for accepting Substitution
   3. Submit shop drawings, product data, and certified test results attesting to proposed substitution equivalence
   4. Burden of proof is on the proposer

B. Limit each request to one proposed Substitution

C. Transmittal Contents:
   1. Identification of proposed Substitution:
      a. Manufacturer's name
      b. Telephone number and representative contact name
      c. Specification section or drawing reference of originally specified product including discrete name or tag number
   2. Manufacturer's literature clearly marked to show compliance of proposed Substitution with Contract Documents
   3. Itemized comparison of original product and proposed Substitution addressing characteristics including but not necessarily limited to:
      a. Size
      b. Composition
      c. Weight
      d. Electrical or mechanical requirements
      e. Installation and maintenance requirements
   4. Product experience:

a. Location of previous projects utilizing product in similar situation per Contract Documents
b. Name and telephone number of persons knowledgeable of proposed product associated with referenced projects
c. Available field data and test reports associated with proposed product

5. Identify any changes to construction schedule or cost required to implement proposed substitution
6. Samples:
   a. Provide in similar manner under provisions of Section 01330 as requested by Engineer
   b. Provide full size sample if requested by Engineer
   c. Samples will be retained by Engineer until substantial completion
   d. Engineer is not responsible for loss or damage to samples

1.7 ACCEPTANCE OR REJECTION

A. Engineer will notify General Contractor in writing of decision to accept or reject request for Substitution:
   1. Decision of Engineer is final
   2. Engineer will affix stamp and indicate acceptance of Substitution with the following stamp:

ACCEPTED SUBSTITUTION

This review was performed for general conformance with the design concept of the project and general compliance with the contract documents based on information provided by the General Contractor. Acceptance by Engineer does not relieve General Contractor from responsibility for providing a complete operating installation including any and all changes and additions necessary to accommodate the substitution. General Contractor is responsible for: dimensions to be confirmed and correlated at the jobsite; information that pertains solely to the fabrication processes or to the means, methods, techniques, sequences, and procedures of construction; coordination of the work of all trades; and for performing all work in a safe and satisfactory manner.

Tetra Tech, Inc.

Date _____ By _____

B. Engineer reserves the right to require proposed Substitution to comply with all aspects of specified product to secure design intent

C. If request for Substitution results in change of Contract Amount or Contract Time, adjustments will be applied under provisions in General Conditions

D. Substitutions will be rejected if:
   1. Submission is not through General Contractor with General Contractor stamp of approval
   2. Requests for Substitution are not made in accordance submission procedures outlined herein
   3. Acceptance will require substantial revision of the original design as determined by Engineer
   4. Substitution is not equal to original product specified or will not adequately perform intended function as determined by Engineer

1.8 REIMBURSEMENT OF SUBSTITUTION REVIEW COSTS

A. In the event Substitutions are proposed to Engineer after award of Contract, Engineer will record all time used by Engineer in evaluating each proposed Substitution

B. General Contractor shall reimburse Engineer for all charges for time spent in evaluating proposed Substitution, whether or not a proposed Substitution is approved:
   1. Costs for Substitution review will be deducted from payments due General Contractor as change order deducts

1.9 DELAYS

A. Delays in construction arising by virtue of the non-availability of a specified material and/or product will not be considered by the Engineer as justifying an extension of the agreed time of Substantial and/or Final Completion

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

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SECTION 01640

MANUFACTURER'S FIELD SERVICES

PART 1 GENERAL

1.01 SCOPE:

This section shall govern the requirements established for Manufacturer's (or Supplier's) field services associated with the installation of equipment.

1.02 RELATED WORK:

A. Section 01330 – Shop Drawings, Product Data and Samples

B. Section 01600 – Common Product Requirements

C. Section 01730 – Operations and Maintenance Data

D. Section 01810 – Starting of Systems

1.03 DESCRIPTION OF WORK:

General Contractor shall arrange for and coordinate the Manufacturer's services as specified below.

1.04 SUBMITTALS:

A. Training Plan (Pre Start Up and Post Start Up):

1. Submit not less than 21 calendar days prior to start of equipment testing and revise as necessary for Engineer's acceptance.

2. Submit Manufacturer's tentative training schedule, training plan, and contact person not less than 60 calendar days prior to commencement of any training.

a. Manufacturer's proposed Training Plan shall include the elements presented in the Outline of Instruction Training Plan specified herein. Specific components and procedures shall be identified in the proposed Training Plan. Hands-on demonstrations planned for the instruction shall be described in the Training Plan. The Manufacturer shall indicate the estimated duration of each segment of the Training Plan.

i. Outline of Instruction Training Plan:

1. Equipment Description and Purpose

2. Equipment operation

3. Detailed component description

4. Equipment preventative maintenance (PM)

5. Equipment troubleshooting

6. Equipment corrective maintenance

3. Provide complete training materials, to include operation and maintenance data as required in this section to be retained by each trainee.

B. Quality Control Submittals:

1. Manufacturer's Certificate of Proper Installation:

a. When specified in the individual equipment specification sections or Equipment Schedule, submit certificate certifying:

i. The product or system has been installed in accordance with the Manufacturer's recommendations, inspected by a Manufacturer's authorized representative, and serviced with the proper lubricants.

ii. Necessary safety equipment has been properly installed.

iii. Electrical and mechanical connections have been made meeting quality and safety standards as required.

iv. Free from undue stress imposed by exterior connections or loads.

v. Proper adjustments have been made and the product or system is ready for testing, facilities startup, operational test, and operation.

b. See Manufacturer's Certificated of Proper Installation Form at end of this Specification.

2. Certificate of Successful Equipment Testing: Prepare and submit where specified in individual equipment specification sections or Equipment Schedule, and upon completion of successful testing of respective equipment by the General Contractor. See Certificate of Successful Equipment Testing Form at end of this Specification.

3. Certificate of Successful Equipment System, Subsystem or Component, Start up Testing including Functional and Performance Tests: Prepare and submit where specified in individual equipment specification sections or Equipment Schedule, and upon completion of successful Start Up testing of respective equipment system, subsystem or component by the General Contractor. See Certificate of Successful Equipment System, subsystem or component Start up Testing Form at end of this Specification.

1.05 QUALIFICATION OF MANUFACTURER'S REPRESENTATIVE:

A. Authorized representative of the Manufacturer, Certified by Manufacturer, factory trained, and experienced in the technical applications, installation, operation, and maintenance of respective equipment, system, subsystem, or component. Representative subject to acceptance by Engineer. No substitute representatives will be allowed unless prior written approval by Engineer has been given.

1.06 FULFILLMENT OF SPECIFIED MINIMUM SERVICES:

A. Where Manufacturer's field services are specified, furnish Manufacturer's representative qualified to provide these services. Where time is necessary in excess of that stated in the Contract Documents for Manufacturer's field services, additional time required to perform the specified services shall be considered incidental work.

B. Coordinate and schedule Manufacturer's field services to avoid conflicting with other field testing or other Manufacturer's field services. Determine that all conditions necessary to allow successful testing have been met before scheduling field services.

C. Only those days of service approved by Engineer will be credited to fulfill the specified minimum services.

D. If specified, Manufacturer’s field services shall include as a minimum:

1. Assistance during installation to include observation, guidance, instruction of General Contractor's assembly, erection, installation or application procedures.

2. Inspection, checking, and adjustment as required for equipment to function as warranted by Manufacturer and necessary to provide written approval of installation.

3. Revisiting the site as required to correct problems and until installation and operation are acceptable to Engineer.

4. Resolution of assembly or installation problems attributable to, or associated with, respective Manufacturer’s products, equipment, system, subsystem and components.

5. Assistance during testing and Start Up demonstration, and until product acceptance by the Engineer.

6. Training of Engineer's personnel in the operation and maintenance of respective products as required herein.

7. Completion of Manufacturer’s Certificate of Proper Installation and applicable certificates of Successful Equipment Testing and Successful Equipment System, Subsystem or Component Start up Testing, as required, including functional and performance tests service. (Forms at the end of this Specification)

1.07 TRAINING SCHEDULE:

A. List specified equipment, system, subsystem, and component with respective Manufacturers that require training services of Manufacturer’s representatives and show:

1. Estimated dates for installation completion.

2. Estimate training dates to allow for multiple sessions when several shifts are involved.

3. Use Equipment Schedule as guidance and revise as needed to meet individual equipment specifications or Manufacturer’s requirements for the preparation of estimated dates. Dates must be included as milestones on general project schedule, and must be coordinated as to allow completion of the project including Start up Phase by Substantial Completion Date.

B. Adjust training schedule to ensure training of appropriate personnel as deemed necessary by Engineer and to allow full participation by Manufacturer’s representatives. Adjust schedule for interruptions in operability of equipment.

C. Training shall not proceed until all individual equipment, systems, subsystems or components have been installed and approved by the Manufacturer’s and completed the testing requirements indicated in Section 01810 – Starting of Systems.

D. Pre Start Up Training:

1. Coordinate and furnish classroom training sessions with the Engineer 's operating personnel and Manufacturer’s representatives.

2. Conduct training prior to as defined in Specification Section 01810 – Starting of Systems.

3. Provide Draft O&M Manuals.

E. Post Start Up Training:

1. Coordinate and furnish on-site training sessions with the Engineer's operating personnel and Manufacturer's representatives.

2. Conduct after Facility Start Up, but prior to Operational Testing of the equipment as defined in Specification Section 01810 – Starting of Systems.

3. Provide Final O&M Manuals in accordance to Section 01730 – Operations and Maintenance Data.

1.08 TRAINING ENGINEER'S PERSONNEL:

A. Provide trained, articulate personnel acceptable to the Engineer to coordinate and expedite training, to be present during training coordination meetings with Engineer and familiar with operation and maintenance manual information.

B. Manufacturer's Representative shall provide the number of days of training for equipment as indicated in the Equipment Schedule section. Operator training days shall be in addition to Manufacturer's field services required as indicated in the Equipment Schedule and submittals sections.

1. All training will be performed during the operating staff's normal business hours and at other times requested and approved by the Engineer.

C. Manufacturer's representatives to provide detailed training to Engineer's personnel on operation and maintenance of specified product (equipment, system, subsystem and component) and as required in applicable Contract Documents. This includes operation, disassembly, and assembly of major equipment items, start up, shutdown, safety concerns, troubleshooting, installation, alignment, and recommended corrective and preventative maintenance procedures for all equipment.

1. Training services include Pre Start Up classroom instruction and Post Start Up onsite hands-on instruction.

2. Manufacturer's Representative shall be familiar with system operation and maintenance requirements for specified equipment, system, subsystem, or component.

D. Taping of Training Sessions: Manufacturer to videotape Pre Start and Post Start Up training sessions and furnish to the Engineer.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION – NOT USED

MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

NEVADA ENVIRONMENTAL RESPONSE TRUST (NERT)
EQPT SERIAL NO.:_____
EQPT TAG NO.:_____ EQPT/SYSTEM: _____
PROJECT NO.:_____ SPEC. SECTION: _____

I hereby certify that the above-referenced equipment/system has been:

(Check Applicable)

- ☐ Installed in accordance with MANUFACTURER'S recommendations.
- ☐ Inspected, checked, and adjusted.
- ☐ Serviced with proper initial lubricants.
- ☐ Electrical and mechanical connections meet quality and safety standards.
- ☐ All applicable safety equipment has been properly installed.

Comments:_____
_____
_____
_____
_____
_____

I, the undersigned Manufacturer's Representative, hereby certify that I am (I) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate his equipment and (iii) authorized to make recommendations required to assure that the equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____

Manufacturer:_____

By Manufacturer's Authorized Representative:_____
(Print Name/Authorized Signature)

CERTIFICATE OF SUCCESSFUL EQUIPMENT TESTING

NEVADA ENVIRONMENTAL RESPONSE TRUST (NERT)
EQPT SERIAL NO.:_____
EQPT TAG NO.:_____ EQPT/SYSTEM: _____
PROJECT NO.:_____ SPEC. SECTION: _____

I hereby certify that the above-referenced equipment/system has been:

(Check Applicable)

- ☐ Serviced for proper operation, efficiency, and capacity.
- ☐ Field adjusted for secure satisfactory operation.
- ☐ Tested continuously under actual or simulated operation conditions.
- ☐ Tested over the full range of speed and pressure.

☐ Tested at every level of control.

Comments:_____
_____
_____
_____
_____
_____

I, the undersigned General Contractor's Representative, hereby certify that I am (I) a duly authorized representative of the General Contractor, (ii) empowered by the manufacturer to inspect, approve, and operate his equipment and (iii) authorized to make recommendations required to assure that the equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____

General Contractor: _____

By Manufacturer/Supplier Authorized Representative: _____
(Print Name/Authorized Signature)

By General Contractor's Authorized Representative: _____
(Print Name/Authorized Signature)

CERTIFICATE OF SUCCESSFUL EQUIPMENT SYSTEM, SUBSYSTEM OR COMPONENT START UP TESTING

NEVADA ENVIRONMENTAL RESPONSE TRUST (NERT)
EQPT SERIAL NO.:_____
EQPT TAG NO.:_____ EQPT/SYSTEM: _____
PROJECT NO.:_____ SPEC. SECTION: _____

I hereby certify that the above-referenced equipment/system has been:

(Check Applicable)

- ☐ Demonstrate all operational features, instrumentation, and control functions while in automatic mode.
- ☐ Checked for proper installation, started and successfully tested.
- ☐ System has been functionally tested, and meets or exceeds specified performance requirements. (When complete system of one manufacturer.)
- ☐ System has been performance tested, and meets or exceeds specified performance requirements. (When complete system of one manufacturer.)
- ☐ Facility is ready for intended operation.

Comments:_____
_____
_____
_____
_____
_____

I, the undersigned General Contractor's Representative, hereby certify that I am (I) a duly authorized representative of the General Contractor, (ii) empowered by the manufacturer to inspect, approve, and operate his equipment and (iii) authorized to make recommendations required to assure that the equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____

General Contractor: _____

By Manufacturer/Supplier Authorized Representative: _____
(If Required) (Print Name/Authorized Signature)

By General Contractor's Authorized Representative: _____
(Print Name/Authorized Signature)

END OF SECTION

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SECTION 01700

CONTRACT CLOSEOUT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Closeout procedures

B. Final cleaning

C. Adjusting

D. General Contractor's closeout submittals

E. Project record documents

F. Warranties

G. Spare parts and maintenance materials

H. Delivery to Engineer

I. Substantial completion

J. Final inspection

K. Reinspection fees

L. Final adjustments of accounts

M. Final application for payment

1.2 RELATED SECTIONS

A. Section 01500—Construction Facilities and Temporary Controls

B. Section 01710—Cleaning

C. Section 01720—Project Record Documents

1.3 CLOSEOUT PROCEDURES

A. Comply with requirements stated in conditions of the Contract and in specifications for administrative procedures in closing out the Work

B. Submit written certification that Contract Documents have been reviewed, Work has been inspected, and that Work is complete in accordance with Contract Documents and ready for Engineer 's inspection

C. Provide submittals to Engineer that are required by governing or other authorities

D. Submit final Application for Payment identifying total adjusted Contract Sum, previous payments, and sum remaining due

1.4 FINAL CLEANING

A. Provide final cleaning under provisions of Section 01710

B. Execute final cleaning prior to final inspection

C. Clean equipment to a sanitary condition

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

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

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

1.5 ADJUSTING

A. Adjusting operating Products and equipment to ensure smooth and unhindered operation

1.6 GENERAL CONTRACTOR'S CLOSEOUT SUBMITTALS

A. Project record documents

B. Spare parts and maintenance materials: As specified in individual sections and as specified herein

C. Evidence of payment and waiver of claims: As specified in General and Supplementary Conditions

D. Two copies of each specified special bond, warranty, and service contract

E. Final inspection reports by all regulatory agencies demonstrating the agencies' final approval

F. At Contract close-out, deliver Record Documents to Engineer.

G. Accompany submittal with transmittal letter in duplicate, containing:
   1. Date
   2. Project title and number
   3. General Contractor's name and address
   4. Title and number of each Record Document
   5. Signature of General Contractor or his authorized representative

1.7 PROJECT RECORD DOCUMENTS

A. Provide project record documents under provisions of Section 01720

B. Maintain on site, one set of the following record documents; record actual revisions to the Work:
   1. Contract Drawings
   2. Specifications
   3. Addenda
   4. Change Orders and other Modifications to the Contract
   5. Reviewed shop drawings, product data, and samples
   6. Field test reports
   7. Construction photographs

C. Store record documents and samples separate from documents used for construction:
   1. Provide files and racks for storage of documents
   2. Provide locked cabinet or secure storage space for samples

D. Record information concurrent with construction progress:
   1. Do not conceal any work until required information is recorded
   2. Legibly mark to record actual construction

E. Specifications and addenda—Legibly mark and record at each Product section description of actual Products installed, including the following:
   1. Manufacturer's name, product model, number, trade name and supplies
   2. Product substitutions or alternates utilized
   3. Changes made by Addenda, field order or change order

F. Record documents and shop drawings: Legibly mark each item to record actual construction including:
   1. Measured depths of foundations in relation to finish floor datum
   2. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements
   3. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work
   4. Field changes of dimension and detail
   5. Details not on original Contract Drawings
   6. Changes made by Field Order or by Change Order

G. Submit documents to Engineer with claim for final Application for Payment

H. File documents and samples in accordance with Data Filing Format of the Uniform Construction Index

I. Maintain documents in clean, dry, legible condition and in good order. Do not use record documents for construction purposes

J. Make documents and samples available at all times for inspection by Engineer

K. Provide felt tip marking pens for recording information in the color code designated by Engineer

L. Label each document "Project Record" in neat, large printed letters

1.8 WARRANTIES

A. Provide duplicate notarized copies

B. Execute and assemble documents from General Contractor, suppliers, and manufacturers

C. Provide Table of Contents and assemble in three “D” side ring binder with durable plastic cover

D. Submit prior to final Application for Payment

E. For items of Work delayed beyond date of Substantial Completion, provide updated submittal within ten days after acceptance, listing date of acceptance as start of warranty period

1.9 SPARE PARTS AND MAINTENANCE MATERIALS

A. Provide products, spare parts, maintenance and extra materials in quantities specified in individual specification sections

B. Deliver to Project site; obtain receipt prior to final payment

C. Store the items in a clean, dry, heated, storage shed, or bonded warehouse

D. Protect all items from damage during storage. Store in sturdy wooden boxes or crates with lid

1.10 DELIVERY TO ENGINEER

A. At or prior to time of inspection for Substantial Completion deliver all required items to Engineer at place on site designated by Engineer.

B. Submit to Engineer detailed invoices of major equipment or systems delivered greater than $10,000 in value:
   1. Organize invoices by specification sections
   2. Indicate on invoice any items delivered which were damaged or defective
   3. Engineer’s representative shall sign invoices certifying that all items listed were delivered and that, unless otherwise noted on the invoice, all items were in good condition at time of delivery to Engineer.

C. Engineer will review invoice for completeness and inform General Contractor promptly of any deficiencies therein

D. General Contractor shall deliver all additional items identified by Engineer and replace all damaged and defective items noted on original invoice before requesting final inspection

E. Invoices for additional and replacement items, signed by General Contractor and Engineer's representatives, shall be submitted

1.11 SUBSTANTIAL COMPLETION

A. When General Contractor considers the Work is substantially complete, he shall submit to Engineer:
   1. A written notice that the Work or designated portion thereof is substantially complete
   2. A list of items to be completed or corrected

B. Within reasonable time after receipt of such notice, Engineer will make an inspection to determine status of completion

C. Should Engineer determine that the Work is not substantially complete:
   1. Engineer will promptly provide written notification, giving reasons therefore
   2. General Contractor shall remedy deficiencies in the Work and send second written notice of Substantial Completion to Engineer
   3. Engineer will reinspect the Work

D. When Engineer finds that the Work is substantially complete, he will:
   1. Prepare and deliver tentative Certificate of Substantial Completion with tentative list of items to be completed or corrected before final payment
   2. After consideration of any objections as provided in Conditions of the Contract and when Engineer considers the Work substantially complete, he will execute and deliver definite Certificate of Substantial Completion with revised tentative list of items to be completed or corrected

E. No Certificate of Substantial Completion will be issued by Engineer until detailed itemized summary is submitted for review

F. Final payment will not be made until all specified spare parts, maintenance materials, and special tools have been delivered to Engineer in acceptable condition

1.12 FINAL INSPECTION

A. When Engineer considers the Work is complete, Engineer shall submit written certification that:
   1. Contract Documents have been reviewed
   2. Work has been inspected for compliance with Contract Documents
   3. Work has been completed in accordance with Contract Documents
   4. Equipment and systems have been tested in the presence of the Engineer's representative and are operational
   5. Work is completed and ready for final inspection

B. Engineer will make an inspection to verify status of completion with reasonable promptness after receipt of such certification

C. Should Engineer consider that the Work is incomplete or defective:
   1. Engineer will promptly provide written notification listing incomplete or defective work
   2. General Contractor shall take immediate steps to remedy stated deficiencies and send second written certification to that the Work is complete
   3. Engineer will reinspect Work

D. When Engineer finds that the Work is acceptable under Contract Documents, Engineer shall request General Contractor to make closeout submittals

1.13 FINAL ADJUSTMENTS OF ACCOUNTS

A. Submit final statement of accounting to Engineer

B. Statement shall reflect all adjustments to contract sum:
   1. Original Contract Sum
   2. Additions and deductions resulting from:
      a. Previous Change Orders
      b. Deductions for uncorrected Work
      c. Deductions for liquidated damages (if applicable to Contract)
      d. Deductions for reinspection payments
      e. Other adjustments
   3. Total Contract Sum, as adjusted
   4. Previous payments
   5. Sum remaining due

1.14 FINAL APPLICATION FOR PAYMENT

A. Submit final Application for Payment in accordance with procedures and requirements stated in conditions of the Contract

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

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SECTION 01710

CLEANING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Hazards and governing control

B. Cleaning materials

C. General work area conditions during construction

D. Interior and exterior (site) cleaning

1.2 RELATED SECTIONS

A. Division 1—General Requirements

B. Cleaning of certain parts of the work described in various sections of the specifications

1.3 STORAGE AND HANDLING

A. Store cleaning products and cleaning wastes in containers specifically designed for those materials

1.4 SCHEDULING

A. Schedule cleaning operations so that dust and other contaminants disturbed by cleaning process will not fall on newly painted surfaces

1.5 HAZARDS AND GOVERNING CONTROL

A. Hazards Control:
   1. Store volatile wastes in covered metal containers and remove from premises daily
   2. Prevent accumulation of wastes which create hazardous conditions
   3. Provide adequate ventilation during use of volatile or noxious substances

B. Conduct cleaning and disposal operations to comply with laws and safety orders of governing authorities including anti-pollution laws:
   1. Do not burn or bury rubbish and waste materials on project site
   2. Do not dispose of volatile wastes such as mineral spirits, oil or paint thinner in storm or sanitary drains

PART 2 PRODUCTS

2.1 CLEANING MATERIALS

A. Cleaning Agents:
   1. Use cleaning materials only on surfaces recommended by cleaning material manufacturer
   2. New and uncontaminated

B. Use only cleaning materials recommended by manufacturer of surface to be cleaned

PART 3 EXECUTION

3.1 GENERAL WORK AREAS DURING CONSTRUCTION

A. Maintain premises and public properties free from accumulations of waste and debris caused by work on this project

B. Prevent dust nuisance attributable to this work

C. Do not drop or throw materials from heights greater than 4 foot or less than 4 foot if conditions warrant greater care

D. Handle materials in a controlled manner with as few handlings as possible

E. Schedule cleaning operations so that dust and other contaminants resulting from cleaning process will not fall on newly painted surfaces

F. Dispose of degradable debris at an approved solid waste disposal site

G. Dispose of nondegradable debris at an approved solid waste disposal site or in an alternate manner approved by Engineer and regulatory agencies

H. Repair, patch, and touch-up marred surfaces to specified finish to match adjacent surfaces

I. On completion of work, leave area in a clean, natural looking condition. Remove all signs of temporary construction and activities incidental to construction of required permanent Work

3.2 INTERIOR CLEANING

A. Cleaning During Construction:
   1. Keep work areas clean so as not to hinder health, safety or convenience of personnel in existing facility operations
   2. At maximum weekly intervals, dispose of waste materials, debris, and rubbish

3. Vacuum clean interior areas when ready to receive finish painting. Continue vacuum cleaning on an as-needed basis, until substantial completion
4. Vacuum clean interior spaces, including inside cabinets
5. Control dust in work areas of existing facilities:
    a. Provide protection to existing electrical and mechanical equipment as required to eliminate detrimental effects due to construction
    b. Check air handling filters in existing units having construction activities. Weekly replace as necessary
    c. Check interior of existing electric panels and vacuum if dust accumulation has occurred at maximum monthly intervals
    d. Sweep all floors, including basins, tunnels, platforms, walkways, and pick up and dispose of all debris at maximum weekly intervals. Use dust suppressant sweeping compound in areas open to areas of existing facility operations

B. Final Cleaning:
1. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from sight-exposed interior and exterior surfaces
2. Wipe all lighting fixture reflectors, lenses, lamps and trims clean
3. Wash and shine glazing and mirrors
4. Polish glossy surfaces to a shine finish
5. Ventilating systems:
    a. Clean permanent filters and replace disposable filters if units were operated during construction
    b. Clean ducts, blowers and coils if units were operated without filters during construction
6. Replace all burned out lamps
7. Broom clean process area floors
8. Mop office and control room floors

3.3 EXTERIOR (SITE) CLEANING

A. Cleaning During Construction:
1. Construction debris:
    a. Confine in strategically located container(s) covered to prevent blowing by wind
    b. Remove from work area to container daily
    c. Haul from site once a week (minimum)
2. Vegetation: Keep weeds and other vegetation trimmed to 3 inch maximum height
3. Remove soils, sand, and gravel deposited on paved areas and walks as required to prevent muddy or dusty conditions:
    a. Do not flush into storm sewer system
4. Comply with stormwater general permit requirements, and monitor and employ best management practices (BMP)

B. Final Cleaning:
   1. Remove trash and debris containers from site:
      a. Re-seed areas disturbed by location of trash and debris containers
   2. Broom clean paved surfaces
   3. Rake clean other surfaces of grounds

3.4 FIELD QUALITY CONTROL

A. During substantial completion walk thru or prior to start-up, conduct an inspection with Engineer to verify acceptable condition of all work areas

END OF SECTION

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SECTION 01720

PROJECT RECORD DOCUMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Maintenance of record documents. Throughout progress of Work, maintain an accurate record of changes in the Contract Documents, and, upon completion of Work, transfer recorded changes to set of Record Documents

1.2 RELATED SECTIONS

A. Section 01330—Shop Drawings, Product Data, and Samples

B. Include, but are not necessarily limited to, General Conditions, Supplementary Conditions, and Sections in Division 1 of these Specifications

C. Individual sections of Technical Specifications

1.3 SUBMITTALS

A. Engineer's acceptance of the current status of Project Record Documents will be a prerequisite to Engineer's recommendation for payment of progress payments and final payment under the Contract

B. Prior to submitting each request for progress payment, secure Engineer's acceptance of the current status of the Project Record Documents

C. Prior to submitting request for final payment, submit the final Project Record Documents to Engineer for acceptance

1.4 QUALITY ASSURANCE

A. Delegate the responsibility for maintenance of Record Documents to one person acceptable to Engineer

B. Accuracy of records:
   1. Thoroughly coordinate changes within Record Documents, making adequate and proper entries on each page of Specifications and each sheet of Drawings and other Documents where such entry is required to show the change properly

2. Accuracy of records shall be such that future search for items shown in the Contract Documents may rely reasonably on information obtained from accepted Project Record Documents

C. Make entries within 24 hours after receipt of information that the change has occurred

1.5 DELIVERY, STORAGE, AND HANDLING

A. Maintain job set of Record Documents completely protected from deterioration and from loss and damage until completion of the Work and transfer of all recorded data to the final Project Record Documents

B. In the event of loss of recorded data, use means necessary to again secure the data for Engineer's acceptance:
1. Such means shall include, if necessary in the opinion of Engineer, removal and replacement of concealing materials
2. In such case, provide replacement to the standards originally required by the Contract Documents

PART 2 PRODUCTS

2.1 RECORD DOCUMENTS

A. Job set: Promptly following receipt of Engineer's Notice to Proceed, secure from Engineer one complete set of all Documents comprising the Contract

B. Final Record Documents: At a time nearing the completion of the Work, secure from Engineer one complete set of blueline copies of all Drawings in the Contract

PART 3 EXECUTION

3.1 MAINTENANCE OF JOB SET

A. Immediately upon receipt of job set, identify each of the Documents with the title, "RECORD DOCUMENTS—JOB SET"

B. Preservation:
1. Devise a suitable method acceptable to Engineer for protecting job set, considering the Contract completion time, the probable number of occasions upon which the job set must be taken out for new entries and for examination, and the conditions under which these activities will be performed
2. Do not use job set for any purpose except entry of new data and for review by Engineer, until start of transfer of data to final Project Record Documents
3. Maintain job set at the site of Work as that site is designated by Engineer

C. Making entries on Drawings:
   1. Using an erasable colored pencil (not ink or indelible pencil), clearly describe the change by graphic line and note as required
   2. Date all entries
   3. Call attention to the entry by a "cloud" drawn around the area or areas affected
   4. In the event of overlapping changes, use different colors for the overlapping changes

D. Make entries in pertinent other Documents accepted by Engineer

E. Conversion of schematic layouts:
   1. In some cases on the Drawings, arrangements of conduits, circuits, piping, ducts, and similar items, is shown schematically and is not intended to portray precise physical layout:
      a. Final physical arrangement is determined by General Contractor, subject to Engineer’s aceeptance.
      b. However, design of future modifications of the facility may require accurate information as to the final physical layout of items which are shown only schematically on the Drawings
   2. Show on the job set of Record Drawings, by dimension accurate to within one inch, the centerline of each run of items described above:
      a. Clearly identify the item by accurate note such as "cast iron drain," "galv. water," and the like
      b. Show, by symbol or note, the vertical location of the item ("under slab," "in ceiling plenum," "exposed," and the like)
      c. Make all identification so descriptive that it may be related reliably to the Specifications
   3. Engineer may waive the requirements for conversion of schematic layouts where, in Engineer's judgment, conversion serves no useful purpose. However, do not rely upon waivers being issued except as specifically issued in writing by Engineer.

3.2 FINAL PROJECT RECORD DOCUMENTS

A. The purpose of final Project Record Documents is to provide factual information regarding all aspects of Work, both concealed and visible, to enable future modification of Work to proceed without lengthy and expensive site measurement, investigation, and examination

B. Acceptance of recorded data prior to transfer:
   1. Following receipt of blueline copies for Final Record Documents, and prior to start of transfer of recorded data thereto, secure Engineer's acceptance of all recorded data
   2. Make required revisions

C. Transfer of data to Drawings:
   1. Carefully transfer change data shown on job set of Record Drawings to the corresponding bluelines, coordinating the changes as required
   2. Clearly indicate at each affected detail and other Drawing, a full description of changes made during construction, and the actual location of items to be located
   3. Call attention to each entry by drawing a "cloud" around the area or areas affected
   4. Make changes neatly, consistently, and with the proper media to assure longevity and legibility

D. Transfer of data to other Documents:
   1. If Documents other than Drawings have been kept clean during progress of Work, and if entries thereon have been orderly and acceptable to Engineer, the job set of those Documents other than Drawings will be accepted as final Record Documents
   2. If any such Document is not acceptable to Engineer, secure a new copy of that Document from the Engineerat his usual charge for reproduction and handling, and carefully transfer the changed data to the new copy for acceptance by Engineer

E. Review and submittal:
   1. Submit completed set of Project Record Documents to Engineer as described above and under provisions of Section 01330
   2. Participate in review meetings as required
   3. Make required changes and promptly deliver final Project Record Documents to Engineer

3.3 CHANGES SUBSEQUENT TO ACCEPTANCE

A. General Contractor has no responsibility for recording changes in Work subsequent to Final Completion, except for changes resulting from Warranty work

END OF SECTION

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SECTION 01730

OPERATION AND MAINTENANCE DATA

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Submittals

B. Format and content of manuals

C. Manual for equipment and systems

D. Manual for materials and finishes

E. Instruction of Engineer's personnel

F. Schedule of submittals

1.2 RELATED SECTIONS

A. Section 01340—Shop Drawings, Product Data, and Samples

B. Section 01400—Quality Control

C. Section 01600 – Common Product Requirements

D. Section 01630 – Product Options and Substitutions

E. Section 01810—Starting of System

F. Division 11 & 13 – Equipment Specifications

1.3 QUALITY ASSURANCE

A. Preparation of data shall be done by personnel:

1. Trained and experienced in maintenance and operation of the described products
2. Completely familiar with requirements of this section
3. Skilled as a technical writer to the extent required to communicate essential data

4. Skilled as a draftsman competent to prepare required drawings

B. Manuals for equipment systems shall be prepared by the equipment manufacturer or system supplier

C. Compile product data and related information appropriate for Engineer's maintenance and operation of products furnished under the Contract

D. Prepare operating and maintenance data as specified in this Section and as referenced in other pertinent sections of Specifications

1.4 SUBMITTALS

A. Submit under provisions of Section 01330

B. Manuals for equipment and systems:

1. Submit 3 preliminary copies prior to the date of shipment of the equipment or system:

a) Engineer will review

b) If approved, "Approved as Submitted," 1 copy will be returned to General Contractor, and 2 copies retained in Engineer's file

c) If approved, "Exceptions Noted," 1 copy will be returned to General Contractor, and 2 copies retained in Engineer's file

d) If not approved, "Revise and Resubmit" or "Rejected," 2 copies will be returned to General Contractor with Engineer's comments for revision and 1 copy retained in Engineer's file. Resubmit 3 revised preliminary copies for Engineer's review

e) Partial payment of 50 percent for equipment and systems on hand or installed will be made for preliminary manuals returned "Exceptions Noted"

f) No partial payments will be made for equipment and systems on hand or installed until preliminary manuals are submitted and approved

2. Submit 3 final copies no less than 30 days prior to putting the equipment or system in service. If final manuals differ from approved preliminary manuals, submit 2 copies of any necessary supplemental material with instructions for insertion for conforming Engineer's copies of preliminary manuals to final manuals:

a) Engineer will compare with approved preliminary manual

b) If identical or otherwise approved, "Approved as Submitted," General Contractor will be so notified. Approved final copies will be transmitted to Engineer

c) If not approved, "Revise and Resubmit," or “Rejected” all copies will be returned to General Contractor for revision or retained by Engineer and the necessary revision data requested from General Contractor at Engineer's option

d) No portion of the Work is substantially complete until final equipment and system manuals relating to that portion of the Work are approved by Engineer

e) Submit 5 copies of any revisions found desirable during instruction of Engineer's personnel with instructions for insertion for revising Engineer’s copies of manual

f) Submit 2 final CD copies of approved final manuals

g) 3 copies of revisions and one CD copy will be transmitted to Engineer

C. Manual for materials and finishes:

1. Submit 3 preliminary copies 15 days prior to request for final inspection:

a) Engineer will review

b) One copy will be returned to General Contractor with comments, 2 copies retained in Engineer's file

c) No final inspection shall be conducted until preliminary manuals are submitted and approved

2. Submit 2 final copies and 2 CD copies, revised in accordance with Engineer's comments, within 10 days after final inspection:

a) Two copies and one CD copy will be transmitted to Engineer

b) No final payment shall be made until final manuals are submitted and approved

D. Additional requirements for specialized instruction of Engineer's personnel are given in the detailed equipment specifications

1.5 FORMAT

A. Prepare data in the form of an instructional manual for use by Engineer's personnel

B. Presentation of Information:

1. Size: 8-1/2 inch by 11 inch

2. Paper: 20 lb weight minimum, white, for typed pages

3. Text: Manufacturer's printed data or neatly typewritten

4. Drawings:

a) Provide reinforced punched binder tab, bind in with text

b) Reduced to 8-1/2 inch by 11 inch by 17 inch and folded to 8-1/2 inch by 11 inch

c) Where reduction is impractical, folded and placed in 8-1/2 inch by 11 inch envelopes bound in text

d) Suitably identified on drawings and envelopes

5. Provide flysheets for each separate product or each piece of operating equipment:

a) Provide typed description of product and major component parts of equipment

b) Provide indexed tabs, may be in color

6. Spine and cover: Identify each volume with typed or printed title "OPERATION AND MAINTENANCE INSTRUCTIONS" preceded by the word. "PRELIMINARY" or "FINAL" as applicable. Final manuals to list information on the cover and the spine. List the following:

a) Title of project, reference Engineer and project location as applicable

b) Identity of separate structure as applicable

c) Identity of general subject matter covered in manual and specification section number

7. As much as possible, assemble and bind material in the same order as specified

C. Binders:

1. Preliminary manuals: Commercial quality permanent 3-ring or 3 post binders with durable, cleanable, hard plastic covers. GBC bound manual may be accepted upon review by Engineer

2. Final manuals: Commercial quality permanent 3-ring or 3 post binders with durable, cleanable, hard plastic covers with clear plastic cover and spine pockets suitable for title and cover inserts. Manufacturer's pre-printed binder may be accepted upon review by Engineer. "Deluxe Round Ring View Binder" as manufactured by Wilson Jones or accepted substitution

D. Arrange content by systems under section numbers and sequence of table of contents of this Project Manual

E. Provide tabbed flyleaf for each separate product and system, with typed description of product and major component parts of equipment

F. CD and/or DVD:

1. Label each CD and/or start-up DVD provided

2. Provide with project name, section and equipment/system label on CD and for CD case

3. When multiple CDs or DVDs are required, provide CD/DVD 3-ring plastic binder sheet(s) for insertion into final O&M manual

1.6 CONTENTS OF EACH VOLUME

A. Neatly typewritten table of contents for each volume, arranged in a systematic order:

B. General Contractor, name of responsible principal, address and telephone number

1. A list of each product required to be included, indexed to the content of the volume

2. List, with each product, the name, address and telephone number of:

a) General Contractor or installer

b) Identify the area of responsibility of each

c) Local source of supply for parts and replacement

3. Identify each product by product name and other identifying symbols as set forth in Contract Documents

C. Product data:

1. Include only those sheets which are pertinent to the specific product

2. Annotate each sheet to:

a) Clearly identify the specific product or installed

b) Clearly identify the data applicable to the installation

c) Delete references to inapplicable information

D. Drawings:

1. Supplement product data with drawings as necessary to clearly illustrate:

a) Relations of component parts of equipment and systems

b) Control and flow diagrams

2. Coordinate drawings with information in Project Record Documents to assure correct illustration of completed installation:

3. Do not use Project Record Documents as maintenance drawings

E. Written text, as required to supplement product data for the particular installation:

1. Organize in a consistent format under separate headings for different procedures

2. Provide a logical sequence of instructions for each procedures

F. Copy of each warranty, bond and service contract issued:

1. Provide information sheet for Engineer's personnel, give:

a) Proper procedures in the event of fracture

b) Instances which might affect the validity of warranties or bonds

1.7 MANUALS FOR EQUIPMENT AND SYSTEMS

A. Provide an operation and maintenance manual for each item of equipment or system listed in the schedule of manuals in the quantity listed in the submittal schedule

B. Content for each of equipment and system as appropriate:

1. Description of unit and component parts:

a) Function, normal operating characteristics and limiting conditions

b) Performance curves, engineering data and supps

c) Complete nomenclature and commercial number of all replaceable parts

2. Operating procedures:

a) Startup, break-in, routine and normal operating instructions

b) Regulation, control, stopping, shutdown and emergency instructions

c) Summer and winter operating instructions, as applicable

d) Special operating instructions

3. Maintenance procedures:

a) Routine operations

b) Guide to "trouble-shooting"

c) Disassembly, repair and reassembly

d) Alignment, adjusting and checking

4. Servicing and lubrication schedule:

a) List of lubricants required

5. Manufacturer's printed operating and maintenance instructions

6. Description of sequence of operation by control manufacturer

7. Original manufacturer's parts list, illustrations, assembly drawings and diagrams required for maintenance:

a) Predicted life of parts subject to wear

b) Items recommended to be stocked as spare parts

8. As-installed control diagrams by controls manufacturer

9. Coordination drawings:

a) As-installed color coded piping diagrams

10. Charts of valve tag numbers with the location and function of each valve

11. List of original manufacturer's spare parts, manufacturer's current prices and recommended quantities to be maintained in storage

12. Other data as required under pertinent sections of specifications

C. Content for each electric and electronic item or system, as appropriate:

1. Description of system and component parts:

a) Function, normal operating characteristics and limiting conditions

b) Performance curves, engineering data and tests

c) Complete nomenclature and commercial number of replaceable parts

2. Circuit directories of panelboards:

a) Electrical service

b) Controls

c) Communications

3. As-installed color coded wiring diagrams

4. Operating procedures:

a) Routine and normal operating instructions

b) Sequences required

c) Special operating instructions

5. Maintenance procedures:

a) Routine operations

b) Guide to "trouble-shooting"

c) Adjustment and checking

6. Supplier's printed operating and maintenance instructions

7. List of original Supplier's spare parts, current prices and recommended quantities to be maintained in storage

8. Other data as required under pertinent sections of specifications

D. Prepare and include additional data when the need for such data becomes apparent during instruction of Engineer's personnel

E. Additional requirements for Operation and Maintenance Data: In compliance with Section 01600 – Common Product Requirements and equipment specified in Divisions 11, 13, and 15.

1.8 MANUAL FOR MATERIALS AND FINISHES

A. Provide a maintenance manual for the materials and finishes listed in the schedule of manuals in the quantities listed in the submittal schedule

B. Content for architectural products, applied materials and finishes:

1. Supplier's data, giving full information on products:

a) Catalog number, size, composition

b) Color and texture designations

c) Information required for reordering special manufactured products

2. Instructions for care and maintenance:

a) Supplier's recommendation for types of cleaning agents and methods

b) Cautions against cleaning agents and methods which are detrimental to the product

c) Recommended schedule for cleaning and maintenance

C. Content for moisture protection and weather exposed products:

1. Supplier's data, giving full information on products:

a) Applicable standards

b) Chemical composition

c) Details of installation

2. Instructions for inspection, maintenance and repair

D. Additional requirements for maintenance data: In compliance with Section 01600 – Common Product Requirements and equipment specified in Divisions 11, 13 and 15.

1.9 INSTRUCTION OF ENGINEER'S PERSONNEL

A. Prior to final inspection or acceptance, fully instruct Engineer’s designated operating and maintenance personnel in the operation, adjustment and maintenance of all products, equipment and system

B. Operation and maintenance manual constitutes the basis of instruction:

1. Review contents of manual with personnel in full detail to explain all aspects of operations and maintenance

C. Additional requirements for specialized instruction of Engineer's personnel are given in the detailed equipment specification

1.10 SCHEDULE OF SUBMITTALS

A. Equipment and systems operation and maintenance manuals and material and finishes manuals shall be prepared as applicable to General Contractor scope of work:

Specification Section	**Type Of Equipment Or System**
Not Used	

B. The materials and finishes manuals shall be prepared for each of the following:

Specification Section	**Type of Equipment or System**
Not Used	

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

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SECTION 01740

WARRANTIES

PART 1 GENERAL

1.01 WORK INCLUDED:

A. Compile specified warranties and bonds.

B. Compile specified service and maintenance contracts.

C. Co-execute submittals when so specified.

D. Review submittals to verify compliance with Contract Documents.

E. Related requirements specified elsewhere:

1. Bid Bond: Instructions to Bidders.

2. Performance and Payment Bonds: General Conditions.

3. Guaranty: General Conditions.

4. General Warranty of Construction: General Conditions.

5. Contract Closeout: Section 01700.

6. Warranties and Bonds required for specific products: As listed herein.

7. Provisions of Warranties and Bonds, Duration: Respective specification sections for particular products.

8. Section 01730 – Operating and Maintenance Data.

1.02 SUBMITTALS REQUIREMENTS:

A. Assemble warranties, bonds and service and maintenance contracts, executed by each of the respective manufacturers, suppliers and General Contractor.

B. Furnish two (2) original signed copies.

C. Table of Contents: Neatly typed, in orderly sequence. Provide complete information for each item.

1. Product, equipment or work item.

2. Firm name, address and telephone number.

3. Scope

4. Date of beginning of warranty, bond or service and maintenance contract.

5. Duration of warranty, bond or service and maintenance contract.

6. Provide information for General Contractor's personnel:

   a. Proper procedure in case of failure.

   b. Instances which might affect the validity of warranty or bond.

7. General Contractor's name, address and telephone number.

1.03 FORM OF SUBMITTALS:

A. Prepare in duplicate packets.

B. Format:

1. Size 8½ x 11 inch, punch sheets for 3-ring binder: Fold larger sheets to fit into binders.

2. Cover: Identify each packet with typed or printed title "WARRANTIES AND BONDS". List:

   a. Title of Project.

   b. Name of Engineer.

C. Binders: Commercial quality, 3-ring, with durable and cleanable plastic covers.

1.04 TIME OF SUBMITTALS:

A. For equipment or component parts of equipment put into service during progress of construction: Submit documents within ten (10) days after inspection and acceptance.

B. Otherwise, make submittals within ten (10) days after date of substantial completion, prior to final request for payment.

C. For items of work, where acceptance is delayed materially beyond the Date of Substantial Completion, provide updated submittal within ten (10) days after acceptance, listing the date of acceptance as the start of the warranty period.

1.05 SUBMITTALS REQUIRED:

A. Submit warranties, bonds and service and maintenance contracts as specified in the respective sections of the Specifications.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION – NOT USED

END OF SECTION

SPECIFICATION REVISION INDEX

Revision No.	Revision Date	Issued for	Signatures				
			Prepared By	Reviewed By	Project Engineer	Project Manager	Client
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SECTION 01750

SPARE PARTS

PART 1 GENERAL

1.01 GENERAL:

A. General Contractor shall furnish spare parts and maintenance materials as specified in the individual Sections.

B. Parts and materials shall be furnished in manufacturers' unopened cartons, boxes, crates or other protective covering suitable for preventing corrosion or deterioration for the maximum length of storage which may be normally anticipated. They shall be clearly marked and identified as to contents and storage instructions.

C. During construction, store parts in buildings or trailers with floor, roof and closed sides and in accordance with manufacturers' recommendations. Protect from weather, condensation and humidity.

D. Parts and materials shall be delivered to the Engineer upon completion of the Work or when the Engineer assumes occupancy. General Contractor shall then place them in permanent storage rooms or areas approved by the Engineer.

E. Provide a letter of transmittal including the following:

1. Date of letter and transfer of parts and material.

2. Contract title and number.

3. General Contractor's name and address.

4. A complete inventory of the parts and material, listing the applicable Specification Section for each.

5. A place for the Engineer to sign and signify receipt of the parts and materials.

F. General Contractor shall be fully responsible for loss or damage to parts and materials until they are transmitted to the Engineer.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION – NOT USED

END OF SECTION

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SECTION 01810

STARTING OF SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Start-up, pre-demonstration and demonstration of facility, systems or equipment

B. Personnel training

C. Testing, adjusting, and balancing

D. Related systems start-up and demonstration period requirements

1.2 RELATED SECTIONS

A. Section 01400—Quality Control

B. Section 01730—Operation and Maintenance Data

C. Division 11 & 13 – Equipment Specifications

1.3 DEFINITIONS

A. Project System: Specific system, consisting of an independent arrangement of equipment, structures, components, piping, wiring, materials or incidentals that performs an identifiable function which is both operational and safe

B. Pre-Demonstration Period: Period of time, of unspecified duration after initial construction and installation during which Supplier's representative performs the following activities in sequence:
   1. Initial equipment start-up
   2. Correction of all discrepancies or functions prior to Demonstration Period

C. Demonstration Period: Period of time, of specified duration, following Pre-Demonstration Period, during which Supplier completes personnel training including review of approved O&M Manuals with Engineer and initiates process flow or product through facility or Project System, starts up and operates facility or project system without exceeding specified downtime limitations, to prove functional integrity of

mechanical and electrical equipment and components and control interfaces to satisfaction of Engineer as evidence of Substantial Completion

D. Related System: Equipment or subsystem whose function is necessary for the start-up, testing and operation of the project system as a whole

E. Substantial Completion: Reference General Conditions and Supplementary Conditions and Contract Closeout requirements.

1.4 SUBMITTALS

A. Submit under provisions of Section 01330

B. Submit in chronological order listed below prior to completion of Pre-Demonstration Period:
   1. Master operation and maintenance training schedule:
      a. Submit 30 days (minimum) prior to first training session for Engineer personnel
      b. Schedule to include:
         1) Target date and time for Engineer witnessing initial start-up of each system
         2) Target date and time for Operation and Maintenance training for each system, both field and classroom
         3) Target date for initiation of Demonstration Period
      c. Submit for review and approval by Engineer
      d. Include holidays observed by Engineer
      e. Attend a schedule planning and coordination meeting 45 calendar days prior to first anticipated training session:
         1) Provide a status report and schedule-to-complete for requirements prerequisite to manufacturer's training
         2) Identify initial target dates for individual manufacturer's training sessions
      f. Engineer reserves the right to insist on a minimum 7 days' notice of rescheduled training session not conducted on master schedule target date for any reason
      g. Resubmit schedule until approved
   2. Substantial Completion Submittal:
      a. Supplier shall file Notice of Substantial Completion, Request for Inspection and documentation under provisions of Section 01730
      b. Approved Operation and Maintenance manuals received by Engineer minimum 1 week prior to scheduled training

c. Written request for Engineer to witness each system pre-demonstration start-up. Request to be received by Engineer minimum 1 week before scheduled training of Engineer personnel on that system
d. Equipment installation and pre-demonstration start-up certifications
e. Letter verifying successful completion of all pre-demonstration start-up activities including receipt of all specified items from manufacturers or suppliers as final item prior to initiation of Demonstration Period
f. Letter verifying successful completion of Demonstration Period start-up activities

1.5 COST OF START-UP

A. Engineer to pay all costs associated with facility, systems or equipment start-up

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 START-UP—GENERAL

A. Supplier shall coordinate with Engineer and General Contractor for schedule of start-up of various equipment and systems

B. Notify Engineer and General Contractor 7 days prior to start-up of each item

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

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

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

F. Provide representative to supervise start-up activities, in accordance with Section 01640.

G. When specified in individual specification Sections, provide authorized representative to be present at site to inspect, check and approve equipment or system installation prior to start-up, and to supervise placing equipment or system in operation

H. Submit a written report in accordance with Section 01400 that equipment or system has been properly installed and is functioning correctly

I. Start-up divided into two periods:
   1. Pre-Demonstration Period including:
      a. Completion of Work to prepare facility, systems or equipment for Demonstration Period
      b. Start-up of equipment
      c. Complete filing of all required submittals
   2. Demonstration Period including:
      a. Demonstration of functional integrity of facility or system
      b. Training of personnel
      c. Review of approved preliminary O&M Manuals with Engineer
      d. Filing of Supplier's Notice of Substantial Completion and Request for Inspection

J. Operation and Maintenance Manuals for equipment or system scheduled for start-up and training:
   1. Prepare and submit manuals in accordance with Section 01730 prior to delivery of equipment or system
   2. Confirm approved preliminary operation and maintenance manuals are available prior to commencing any equipment or system training activities
   3. Start-up and demonstration period of equipment or system will not be complete, nor will start-up and demonstration period payments be made, until Supplier's authorized representative includes a complete and thorough review of the approved preliminary O&M Manual with Engineer during the equipment training session

3.2 PRE-DEMONSTRATION PERIOD

A. Equipment Start-up:
   1. Requirements for individual items of equipment are included in Divisions 2 through 16 of these Specifications
   2. Prepare equipment to operate properly and safely and be ready to demonstrate functional integrity during Demonstration Period
   3. Perform equipment start-up to extent possible without introducing product flow
   4. Test tanks, pumping, filters, and similar equipment requiring a fluid, using clean water supplied at Engineer's expense
   5. Dispose of water used for equipment start-up
   6. Procedures include, but are not necessarily limited to the following:
      a. Test or check and correct deficiencies of:

1) Power, control, and monitoring circuits for continuity prior to connection to power source
2) Voltage of all circuits
3) Phase sequence
4) Cleanliness of connecting piping systems
5) Alignment of connected machinery
6) Vacuum and pressure of all closed systems
7) Lubrication
8) Valve orientation and position status for manual operating mode
9) Tankage for integrity using Stabilized Lake Mead Water
10) Pumping equipment using Stabilized Lake Mead Water
11) Instrumentation and control signal generation, transmission, reception, and response as required under provisions of the Specifications
12) Tagging and identification systems
13) All equipment: Proper connections, alignment, calibration and adjustment

b. Calibrate all safety equipment
c. Manually rotate movable parts to assure freedom of movement
d. "Bump" start electric motors to verify proper rotation
e. Perform other tests, checks, and activities required to make equipment ready for Demonstration Period
f. Documentation:
1) Prepare log showing each equipment item subject to this paragraph and listing what is to be accomplished during equipment start-up
2) Provide place for Supplier to record date and person accomplishing required work. Submit completed document before requesting inspection for Substantial Completion certification

7. Obtain certifications, without restrictions or qualifications, and deliver to Engineer:
a. Supplier's equipment installation check letters
b. If required, instrumentation supplier's instrumentation installation certificate

3.3 PERSONNEL TRAINING

A. Reference individual equipment specification sections

B. Conduct all personnel training after completion of equipment start-up for the equipment for which training is being conducted:

1. Personnel training on individual equipment or systems will not be considered completed unless:
    a. All pre-training deliverables are received and approved before commencement of training on the individual equipment or system
    b. No system malfunctions occur during training
    c. All provisions of field and classroom training specifications are met
2. Training not in compliance with the above will be performed again in its entirety by the manufacturer at no additional cost
3. Videotape each training session

C. Field and classroom training requirements:
1. Hold classroom training on-site
2. Notify each manufacturer specified for on-site training that Engineer reserves the right to video record any or all training sessions. Organize each training session in a format compatible with video recording
3. Training instructor: Factory trained and familiar with giving both classroom and "hands-on" instructions
4. Training instructors: Be at classes on time. Session beginning and ending times to be coordinated with the Engineer and General Contractor and indicated on the master schedule. Normal time lengths for class periods can vary, but brief rest breaks should be scheduled and taken
5. Organize training sessions into maintenance verses operation topics and identify on schedule
6. Plan for minimum class attendance of 15 people at each session and provide sufficient classroom materials, samples, and handouts for those in attendance
7. Instructors to have a typed agenda and well prepared instructional material. The use of visual aids, e.g., films, pictures, and slides is recommended for use during the classroom training programs. Deliver agendas to the Engineer a minimum of 7 days prior to the classroom training. Provide equipment required for presentation of films, slides, and other visual aids
8. Cover information required in Operation and Maintenance manuals submitted according to Sections 01330 and 01730 and following areas as applicable to project systems:
    a. Operation of equipment
    b. Lubrication of equipment
    c. Maintenance and repair of equipment
    d. Troubleshooting of equipment
    e. Preventive maintenance procedures
    f. Adjustments to equipment
    g. Inventory of spare parts
    h. Optimizing equipment performance

i. Capabilities
j. Operational safety
k. Emergency situation response
l. Takedown procedures (disassembly and assembly)

9. Address above paragraphs a), b), h), I), j) and k) in the operation sessions
10. Address above paragraphs c), d), e), f), g), and l) in the maintenance sessions
11. Maintain a log of classroom training provided including: Instructors, topics, dates, time, and attendance

D. Complete filing of all required submittals:
1. Shop Drawings
2. Operation and Maintenance Manuals
3. Training material

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

F. Amount of time required for instruction on each item of equipment and system is that specified in individual sections

3.4 DEMONSTRATION PERIOD

A. Demonstrate operation and maintenance of Products to Engineer personnel within 14 days prior to date of Substantial Completion unless specified otherwise by requirements of construction staging per the Supplier's requirements.

B. Utilize operation and maintenance manuals as basis for instruction. Review contents of manual with Engineer personnel in detail to explain all aspects of operation and maintenance.

C. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment at scheduled times, at equipment location.

D. Demonstrate the functional integrity of the mechanical, electrical, and control interfaces of the respective equipment and components comprising the facility or system as evidence of Substantial Completion.

E. If, during the Demonstration Period, the aggregate amount of time used for repair, alteration, or unscheduled adjustments to any equipment or system that renders the affected equipment or system inoperative exceed 10 percent of the Demonstration Period, the demonstration of functional integrity will be deemed to have failed. In the event of

failure, a new Demonstration Period will recommence after correction of the cause of failure. The new Demonstration Period shall have the same requirements and duration as the Demonstration Period previously conducted.

F. Conduct the demonstration of functional integrity under full operational conditions.

G. Engineer will provide operational personnel to provide process decisions affecting plant performance. Engineer's assistance will be available only for process decisions. Supplier will perform all other functions including but not limited to equipment operation and maintenance until successful completion of the Demonstration Period.

H. Engineer reserves the right to simulate operational variables, equipment failures, routine maintenance scenarios, etc., to verify the functional integrity of automatic and manual backup systems and alternate operating modes.

I. Duration of Demonstration Period: Minimum of 7 consecutive days:
   1. Time of beginning and ending of any Demonstration Period will be agreed upon by Supplier, Engineer and General Contractor in advance of initiating Demonstration Period
   2. Length of Demonstration Period other than specified will be agreed upon by Supplier, Engineer and General Contractor in advance of initiating Demonstration Period

J. Provide knowledgeable personnel to answer Engineer's questions throughout the Demonstration Period.

K. Provide final field instruction on select systems and respond to any system problems or failures which may occur.

L. Provide all labor, supervision, utilities, chemicals, maintenance, equipment, vehicles or any other item necessary to operate and demonstrate all systems being demonstrated.

3.5 TESTING, ADJUSTING, AND BALANCING

A. Perform testing, adjusting and balancing under provisions of related Sections

B. Reports will be submitted by an independent firm to the Engineer indicating observations and results of tests and indicating compliance or non-compliance with specified requirements and with the requirements of the Contract Documents.

3.6 RELATED SYSTEMS START-UP AND DEMONSTRATION PERIOD

A. Demonstration periods and other start-up requirements for individual system components may or may not be concurrent with Related Systems Demonstration Period

B. Requirements for individual components may vary with construction staging, time, performance testing stipulations, construction schedule, etc. Individual equipment start-up and performance testing requirements may exceed the Related System Demonstration Period requirement.

C. Personnel Requirements:
   1. Supplier's Authorized Representative (field engineer) for all components of equipment, electrical Supplier and instrumentation and controls Supplier must be present onsite, or within one hour travel time to the site, for the entire length of the Related Systems Demonstration Period.
   2. If equipment system consists of mechanical components and instrumentation and control components, such as programmable logic controllers (PLC's), more than one field engineer per piece of equipment may be required to be present during the Related System Demonstration Period. Manufacturer to provide as many field engineers as necessary to successfully trouble-shoot, start-up and demonstrate all components of equipment during Related System Demonstration Period.
   3. Manufacturer's sales representative is not be an acceptable substitution for authorized start-up representative (field engineer).

D. Length of Related System Demonstration Period: Five (5) consecutive days
   1. Time requirements for Supplier's Authorized Representatives to be onsite are in addition to the times listed in the respective equipment specification sections of this Contract.
   2. If Related System is fully functional and operational in automatic mode for all system components to the satisfaction of the Engineer, the Related System Demonstration Period may be shortened at the discretion of the Engineer and Supplier.
   3. Shortening of the Related System Demonstration Period in no way reduces the start-up and testing requirements of individual equipment.

E. Failure of Related Systems Demonstration Period:
   1. If, during the Related Systems Demonstration Period, the aggregate amount of time used for repair, alteration, or unscheduled adjustments to any equipment or systems that render the water treatment system inoperative exceed 60 percent of the Demonstration Period, the demonstration of functional integrity will be deemed to have failed.

2. In the event of failure, the Related Systems Demonstration Period will recommence after correction of cause of failure.
3. Additional Related Systems Demonstration Period shall have the same requirements and duration as the Related Systems Demonstration Period previously attempted.
4. Coordination and completion of a subsequent Related Systems Demonstration Period, if required due to equipment failure or absence of key personnel, shall be conducted at no additional cost.
5. Successful completion of Related Systems Demonstration Period is required per Engineer's requirements for continuation of construction schedule. No additional contract time will be granted for time lost due to failure of Related Systems Demonstration Period.

END OF SECTION

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SECTION 02050

DEMOLITION

PART 1 GENERAL

1.01 DESCRIPTION:

A. Scope of Work:

1. This section includes furnishing all labor, materials, permits, notifications, equipment and incidentals required for the demolition and disposal of all materials and equipment to be removed.

2. This section provides for the complete removal and disposal of specified existing structures, foundations, slabs, piping, mechanical, electrical, and miscellaneous appurtenances encountered during construction operations.

3. These specifications call attention to certain activities necessary to maintain and facilitate operation during and immediately following construction and do not purport to cover all of the activities necessary. The General Contractor shall exercise due care to maintain continuous operation of the existing facilities and minimize operation inconvenience. In accordance with this requirement, a Demolition and Removal Plan shall be developed by the General Contractor and submitted to the Engineer for review.

4. Demolition includes:

a. Demolition includes, but not limited to, milling and removal of existing pavement, lime silo, and the existing subgrade under the lime silo.

b. Disposal of nonsalvageable and excess unacceptable material as specified below.

c. Off-site disposal of excess and unacceptable materials.

5. The General Contractor shall examine the Contract Documents regarding the proposed site, visit the proposed site and determine for himself the extent of the work affected therein, and all conditions under which he is required to perform the various operations.

1.02 PERMITS AND NOTICES:

A. Permits and Licenses: The General Contractor shall obtain all necessary permits and licenses for performing the work and shall furnish a copy of same to the Engineer prior to commencing the Work. The General Contractor shall comply with the requirements of the permits.

B. Notices: The General Contractor shall issue written notices of planned demolition to companies or local authorities owning utility conduit, wires or pipes running to or through the project site. Copies of said notices shall be submitted to the Engineer.

C. Utility Services: General Contractor shall notify utility companies or local authorities furnishing gas, water, electrical, telephone, cable television, or sewer service to remove any equipment owned by them in structures to be demolished and to remove, disconnect, cap, or plug their services to facilitate demolition.

1.03 CONDITIONS AND STRUCTURES:

A. Conditions existing at the time of inspection for bidding purposes will be maintained by the General Contractor insofar as feasible.

1.04 RULES AND REGULATIONS:

A. The Nevada Building Code and applicable codes shall control and demolition, modification, or alteration of the existing buildings or structures.

B. No blasting shall be done on site. The General Contractor shall not bring or store any explosives on site.

1.05 DISPOSAL OF MATERIAL:

A. Salvageable material shall become the property of the Engineer, if the Engineer requests any specific item. The General Contractor shall dismantle all the materials to such a size that it can be readily handled, and deliver any of this salvageable material requested by the Engineer to a designated storage area on-site, as directed by the Engineer.

B. The following examples are the types of material of which the Engineer may maintain Ownership:

1. Pipes and valves greater than 3 inches in diameter (exclusive of buried pipe).

2. All machinery and equipment.

3. All electric panels.

4. Scrap aluminum or other valuable metals

C. Any materials that the Engineer rejects shall become the General Contractor’s property and must be removed from the site.

D. Concrete, concrete block, and unsalvageable bricks shall be hauled to a waste disposal site by the General Contractor.

E. The storage of or sale of removed items on the site will not be allowed.

1.06 SUBMITTALS:

A. Submit to the Engineer within twenty (20) days after the Notice-to-Proceed for approval, five (5) copies of the proposed Demolition and Removal Plan for the structures and modifications as shown on the Drawings or as specified herein prior to the start of Work. Include in the schedule, the coordination of shutoff, capping and continuation of utility service as required. The Demolition and Removal Plan shall include as a minimum, the following:

1. A detailed sequence of demolition and removal work to ensure the uninterrupted progress of the Engineer's operations, and the expeditious completion of the General Contractor's work.

2. A list of all activities, including Engineer’s activities, bypass activities and shutdowns, required to complete the work.

3. Evidence (by signature) of approval of the Engineer’s plant operator of the work plan.

4. The sequence of demolition and renovation of existing facilities will be in accordance with the approved Demolition and Removal Plan as specified in Paragraph 3.02 of this Section. The General Contractor is solely responsible for construction and demolition sequencing of the Work.

B. Before commencing demolition work, all modifications necessary to bypass the affected structure will be completed. General Contractor shall coordinate with the Engineer’s personnel to determine the locations of the affected valves and fittings.

C. The above procedure must be followed for each individual demolition operation.

1.07 TRAFFIC AND ACCESS:

A. Conduct demolition and modification operations, and the removal of equipment and debris to ensure minimum interference with roads, streets, and sidewalks both on-site and off-site and to ensure minimum interference with occupied or used facilities.

B. The General Contractor shall at all times maintain safe and convenient access to the existing site.

C. Do not close or obstruct streets or walks without permission from the Engineer. Provide alternate traffic routes around closed or obstructed access ways.

D. Special attention is directed towards maintaining safe and convenient access to the existing facilities remaining in service by plant personnel and plant associated vehicles. Relocation of the Engineer's materials, labor, or equipment due to uncoordinated interruption will be at the General Contractor's expense.

1.08 DAMAGE:

A. Promptly repair damage caused to adjacent facilities by demolition operations at no cost to the Engineer.

1.09 UTILITIES:

A. Maintain existing utilities to remain in service and protect against damage during demolition operations.

B. Do not interrupt existing utilities serving occupied or used facilities, except when authorized by the Engineer. Provide temporary service during interruptions to existing utilities as acceptable to the Engineer.

C. The General Contractor shall cooperate with the Engineer to shut off utilities serving structures of the existing facilities as required by demolition operations.

D. The General Contractor shall be solely responsible for making all necessary arrangements and for performing any necessary work involved in connection with the discontinuance or interruption of all public and private utilities or services under the jurisdiction of the utility companies.

E. All utilities being abandoned shall be disconnected and terminated at the service mains in conformance with the requirement of the utility companies or the municipality owning or controlling them.

1.10 POLLUTION CONTROL:

A. The sequence of demolition and renovation of existing facilities will be in accordance with the approved Demolition and Removal Plan as specified in this Section. The General Contractor is solely responsible for construction and demolition sequencing of the work in accordance with Section 3.02.

B. For pollution control, use water sprinkling, temporary enclosures, and other suitable methods as necessary to limit the amount of dust and dirt rising and scattering in the air to the lowest level of air pollution practical for the conditions of work. Comply with the governing regulations.

C. Take all necessary measures and means to provide dust, dirt, debris and paint abatement methods to prevent damage to surrounding residential properties, on-site structures, and private property.

D. Clean on-site structures and improvements of all dust, dirt and debris caused by demolition operations as directed by the Engineer. Clean or repair all off-site residential and private property as directed by the Engineer. Return areas to conditions existing prior to the start of work.

1.11 QUALITY CONTROL:

A. Protect all existing materials and equipment to be salvaged or reused from damage.

B. No pipes, junction boxes, conduits, or wires are to be left abandoned.

C. Leave all exposed ends of all pipe and conduit or junction boxes covered and safe.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION

3.01 GENERAL:

A. The General Contractor shall have a basic understanding of the operation of the existing facilities before preparation of the Demolition and Removal Plan to maintain plant operation and reliability during the demolition process.

3.02 SUMMARY OF WORK:

A. See the identified area on the plans for the limits of the demolition.

3.03 BURIED PIPING:

A. Remove all demolished and abandoned buried piping encountered during excavation unless otherwise directed by Engineer.

3.04 MISCELLANEOUS CONCRETE SLABS, ROADWAYS AND SIDEWALKS:

A. Remove concrete slab and lime silo where shown on the drawings or where necessary for the construction of the new structures or modifications of existing structures.

END OF SECTION

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SECTION 02200

EARTHWORK

PART 1 GENERAL

1.1 DESCRIPTION

A. Clearing, grubbing, and site preparation

B. Removal and disposal of debris

C. Handling, storage, transportation, and disposal of excavated material

D. Sheeting, shoring, bracing, and protection work

E. Pumping and dewatering as required or necessary

F. Backfilling

G. Pipe embedment

H. Construction of fills and embankments

I. Trench Stabilization

J. Final grading

K. Slope Stabilization

L. Erosion Control and Stormwater Management Plan

M. Appurtenant work

1.2 RELATED SECTIONS

A. Section 01330 – Shop Drawings, Product Data and Samples

B. Section 01400 –Quality Control

C. Section 01450 – Special Inspection and Testing

D. Section 03000—Concrete

E. *Report of Geotechnical Investigation, Weir Dewatering Treatment, Central Water Treatment Plant, Nevada Environmental Response Trust, Henderson, Nevada,* Tetra Tech, February 14, 2017.

F. *Report of Geotechnical Investigation, Weir Dewatering Treatment, Pump Stations, Nevada Environmental Response Trust, Henderson, Nevada,* Tetra Tech, February 14, 2017.

1.3 REFERENCES

A. ASTM C33—Concrete Aggregates

B. ASTM C136—Sieve Analysis of Fine and Coarse Aggregates

C. ASTM D1241—Material for Soil Aggregate Subbase, Base, and Surface Courses

D. ASTM D698—Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5 lb Rammer and 12-Inch Drop

E. ASTM D1557—Test Methods for Moisture—Density Relations of Soils and Soil-Aggregate Mixtures Using 10-lb Rammer and 18 inch drop

F. ASTM D4253—Test Methods for Maximum Index Density of Soils Using a Vibratory Table

G. ASTM D4254—Test Methods for Minimum Index Density of Soils and Calculations of Relative Density

H. ASTM D2922—Test Methods for Density of Soil and Soil-Aggregate Mixtures in Place by Nuclear Methods (Shallow Depth)

I. ASTM D3017—Test Method for Moisture Content of Soil and Soil-Aggregate Mixtures

1.4 SUBMITTALS

A. Submit under provisions of Section 01330

B. Product Data: Submit on all products or materials supplied herein

C. Test Reports: Indicate sieve analysis, optimum moisture content and density in accord and with ASTM D1557 for cohesive soils including onsite native material. Indicate supplier, sieve analysis, and maximum relative density in accord with ASTM D4253 and D4254 for crushed rock or gravel, pipe embedment and other cohesionless material for fills and embankment

1.5 REGULATORY REQUIREMENTS

A. Where burning is allowed, comply with all codes, regulations and laws, and obtain all necessary permits relative to burning, fire prevention and air pollution

B. Comply with all requirements of County Erosion Control Permit, and State Construction Dewatering Permit

1.6 ENVIRONMENTAL REQUIREMENTS

A. Protect adjacent structures and surrounding areas from damage during excavation, filling, and backfilling

B. Protect work from erosion or other similar types of damage until the project has been completed

C. Do not backfill or construct fills during freezing weather. Backfill or construct fills only when temperature is 35 degrees F and rising

D. Do not use frozen materials, snow, or ice in any backfill or fill area

E. Do not backfill or construct fill on frozen surfaces

F. Protect excavated material from becoming frozen

G. Do not remove trees from outside excavation or fill areas unless authorized by the Engineer; protect from permanent damage by construction activities

H. Provide temporary bridges for roadways, walkways, driveways, etc.

PART 2 PRODUCTS

2.1 MATERIALS

A. Classification of Excavated Materials:
   1. None
   2. Remove and handle excavated materials regardless of type, character, composition, condition, or depth of material at no additional cost to Engineer.
   3. Remove and handle excavated materials regardless of means, methods, and techniques required, at no additional cost to Engineer.

B. Fills and Embankments:
   1. To the max extent practical use excess earth from excavation for fills and embankments

2. Obtain additional material from borrow areas as necessary
3. Free from rocks or stones larger than 6 inch in greatest dimension and free from brush, stumps, logs, roots, debris, and organic and other deleterious materials
4. Fill and embankment material acceptable to Engineer
5. No rocks or stones larger than ½-inch in upper 18 inches of fill or embankment or in contact with the HDPE geomembrane layer.
6. Where allowed, distribute rocks and stones through the fill to not interfere with compaction
7. Crushed rock or gravel: Graded 12 inch to No. 4, ASTM C33, free of dust, clay or trash

C. Topsoil:
1. Native material removed and stockpiled before excavation
2. Free from trash, debris, surface vegetation more than 6 inch high

D. Pipe Embedment: Crushed graded gravel or native material
1. Washed Rock—1-1/2 inch minus:

Sieve Size (Inch)	Percent Passing by Weight
2	100
1-1/2	95-100
1	80-95
3/4	30-45
1/2	10-25
3/8	<1

2. Washed Rock—3/4 inch minus:

Sieve Size (Inch)	Percent Passing by Weight
1	100
3/4	95-100
1/2	25-45
3/8	<5

3. Washed 3/8 inch pea gravel
4. Squeegee (May not be used in high groundwater area):

Sieve Size (Inch)	Percent Passing by Weight
3/8	100
No. 4	85-100

Sieve Size (Inch)	Percent Passing by Weight
No. 8	30-70
No. 16	5-40
No. 30	0-15
No. 50	0-10
No. 100	0-5
No. 200	<1

5. Finely divided site excavated material free from debris, clay lumps, organic material and stones larger than 1.5 inches in greatest dimension
6. Coal-tar coated steel pipe: Use pea gravel only

E. Compacted Trench Backfill:
1. Job excavated material finely divided, free of debris, organic material, and stones larger than 3 inch in greatest dimension without masses of moist stiff clay.
2. Graded gravel or native material: As specified for pipe embedment

F. Trench Cover:
1. Free of brush, debris and roots
2. May contain rubble and detritus from rock excavation, stones and boulders if well separated and arranged not to interfere with backfill settlement
3. In upper 18 inch no rock or rock excavated detritus except with specific approval of Engineer
4. No stones larger than 8 inch in greatest dimension within 3 feet of top of pipe

G. Compacted Structural Backfill:
1. Earth only, free of wood, grass, roots, broken concrete, stones, trash, or debris of any kind
2. Moisture content uniformly distributed and such that max density of compacted soil will be obtained

H. Flowable Backfill: Regular, or quick set.

Component	Regular Flowable Fill	Quick Set Flowable Fill
Cement (Type II)	42 lbs	47 lbs
Fly Ash (Class F)	-0- lbs	250 lbs
Sand	1,845 lbs	1,600 lbs
Rock/Limestone	1,700 lbs	1,755 lbs
Water	325 lbs	341 lbs
Accelerator (Pozz. 20)	–0- oz	23-1/2 oz
AEA	-0- oz	45 oz

1. Maximum desired 28-day strength: 60 psi
2. Batch plant mix design based on per cubic yard
3. Sand: AASHTO M6
4. Rock/Limestone: AASHTO No. 57 or 67

I. Ditch check: Concrete except as indicated on Drawings or accepted by Engineer

2.2 ACCESSORIES

A. Straw bales used for erosion control barriers: Wire or string wound and less than one year old. Do not use bales in an advanced state of deterioration regardless of age

B. Stakes for erosion control bales: No. 4 reinforcing steel or 2-inch by 2-inch wood stakes

C. Erosion Control Fabric: Straw or coconut fiber combination blanket for temporary protection of steep sloped areas:
1. “S-2” as manufactured by Bon Terra America
2. “S150” as manufactured by North American Green
3. Or approved equal

D. Silt Fence Fabric: Woven polypropylene:
1. Mirafi 100X for “Envirofence” installations
2. Or approved equal

PART 3 EXECUTION

3.1 EXAMINATION

A. Field verify the location of all underground utilities, pipelines and structures prior to excavation

3.2 PERFORMANCE—GENERAL

A. Perform work in a safe and proper manner with appropriate precautions against hazard

B. Provide adequate working space and clearances for work performed within excavations and for installation and removal of concrete forms

C. Do not undercut excavation faces for extended footings

D. Clean subgrades of loose material before concrete is placed thereon

E. Except as otherwise authorized, indicated, or specified, replace all material excavated below the bottom of concrete walls, footings, slabs on grade and foundations with concrete placed at the same time and monolithic with the concrete above

F. Except where exterior surfaces are to be dampproofed concrete structures that do not have footings that extend beyond the outside face of exterior walls may be placed directly against excavation faces without outer forms

G. Excavation for masonry structures to provide 6 inch minimum clearance for outside plastering

3.3 PREPARATION

A. Clear sites to be occupied by permanent construction of roots, brush, and other objectionable material and debris

B. Clean and strip subgrade for fills and embankments of surface vegetation, sod, tree stumps and organic topsoil

C. Remove waste materials from site and dispose

D. Preparation of right of ways-clean, as necessary, for access, stringing of pipeline materials and construction of pipelines and appurtenant structures

E. Remove debris, all trees, underbrush, stumps, roots and other combustible materials from site daily and dispose of off-site; on-site burning is not permitted

F. Do not use open burning

3.4 PRESERVATION OF TREES

A. Do not remove trees outside fill or excavated areas, except as authorized by Engineer

B. Protect trees left standing from permanent damage by construction operation

C. Trim standing trees as directed by Engineer

3.5 TOPSOIL

A. Remove and stockpile sufficient topsoil to surface to a minimum depth of 4 inches fill, embankment and other areas where the original topsoil will be covered or damaged

B. At the completion of other work in each area, place and grade topsoil to maintain gradient as indicated

3.6 DEWATERING

A. Provide and maintain adequate dewatering equipment to remove and dispose of surface and groundwater entering excavations, trenches, and other parts of the work

B. Keep each excavation dry during subgrade preparation and continually thereafter until the structure to be built or the pipe to be installed is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result

C. Dewater excavations which extend to or below groundwater by lowering and keeping the groundwater level beneath such excavation at least 12 inches below the bottom of the excavation

D. Divert surface water or otherwise prevent it from entering excavated areas or trenches to the extent practical without damaging adjacent property

E. Maintain all drainage pipes, keep clean and free of sediment during construction and final cleanup

F. Reference *Report of Geotechnical Investigation, Weir Dewatering Treatment, Central Water Treatment Plant, Nevada Environmental Response Trust, Henderson, Nevada,* Tetra Tech, dated February 14, 2017, and *Report of Geotechnical Investigation, Weir Dewatering Treatment, Pump Stations, Nevada Environmental Response Trust, Henderson, Nevada,* Tetra Tech, dated February 14, 2017.

G. Obtain and comply with conditions of construction dewatering permit.

3.7 SHEETING, SHORING AND BRACING

A. Provide proper and substantial sheeting, shoring, and bracing, as required, to prevent caving or sliding, to protect workmen and the Work, and to protect existing structures and facilities

B. Design and build sheeting, shoring, and bracing to withstand all loads that might be caused by earth movement or pressure, and to be rigid, maintaining shape and position under all circumstances

C. Do not pull trench sheeting before backfilling unless pipe strength is sufficient, to carry trench loads based on trench width to the back of sheeting

D. Do not brace sheeting left in place against the pipe, but support it in a manner that precludes concentrated loads or horizontal thrusts on pipe

E. Cross braces installed above the pipe to support sheeting may be removed after pipe embedment is completed

3.8 TRENCH STABILIZATION

A. Thoroughly compact and consolidate subgrades for concrete structures, precast structures, and utility trench bottoms so they remain firm, dense and intact during required construction activities

B. Remove all mud and muck during excavation

C. Reinforce subgrades with crushed rock or gravel if they become mucky during construction activities

D. Finished elevation of stabilized subgrades are to be at or below subgrade elevations indicated on Drawings

E. Allow no more than 2 inch depth of mud or muck to remain on trench bottoms when pipe bedding material is placed thereon

3.9 CRUSHED ROCK OR GRAVEL FILLS

A. Place on suitably prepared subgrade and compacted

B. Compacted by vibration

C. Where covered with concrete, grade gravel to required subgrade and cover with polyethylene film

3.10 ROADWAY EXCAVATION AND SUBGRADE PREPARATION

A. Excavate for roadways, drives and parking area per the lines, grades cross sections and dimensions indicated on Drawings

B. Excavate unsuitable material from the subgrade

C. After shaping, roll subgrade compacted to 95% (for roadways) and 100% (for under foundations) of maximum density within ±2% optimum moisture content, ASTM D1557, to a minimum depth of 6 inch

D. Reshape and wet as required

E. Remove soft or otherwise unsuitable material, and replace with suitable material

3.11 BUILDING EXCAVATION

A. Excavate subsoil required to accommodate building foundations, slabs on grade, hoppers, wet wells and equipment pads

B. Machine slope banks to stable configuration

C. Grade top perimeter of excavation to prevent surface water from draining into excavation

D. Excavate with heavy duty conventional excavation equipment

E. Do not overexcavate and minimize extent of excavation where possible

F. Correct areas overexcavated with suitable on-site material or gravel fill

3.12 FILLS AND EMBANKMENTS

A. Level and roll subgrade so surface materials will be compact and bond with the first layer of fill or embankment

B. Place in horizontal layers 8 inch max uncompacted depth

C. Spread and level material deposited in piles and windrows before compacting

D. Thoroughly compact each layer by rolling or other means acceptable to Engineer to 95% maximum dry density within ±2% optimum moisture content, ASTM D1557

E. Alter compaction methods if material fails to meet specified density

F. Where a trench passes through a fill or embankment, place and compact fill or embankment to 12 inch above the top of the pipe before excavating the trench

G. Add water and harrow, disc, blade, or otherwise work each layer to obtain the uniform moisture content and adequate compaction

H. The embankment around the Secondary Containment Area should be over-built at least 1 inch to account for additional settlement due to the Process Tanks inside in the Area, per the recommendations in the *Report of Geotechnical Investigation, Weir Dewatering Treatment, Central Water Treatment Plant, Nevada Environmental Response Trust, Henderson, Nevada*, Tetra Tech, dated February 14, 2017, and *Report of Geotechnical Investigation, Weir Dewatering Treatment, Pump Stations, Nevada Environmental Response Trust, Henderson, Nevada*, Tetra Tech, dated February 14, 2017.

3.13 FILLS AND EMBANKMENTS OVER STRUCTURES

A. Use methods which will not damage or overload structure

B. Use rubber tired vehicles to extent practicable

C. Do not use equipment with a loaded weight greater than 14,000 pounds

D. Operate equipment to prevent impact loads on structure

E. Distribute equipment loads with planks or a layer of earth or gravel 12 inch minimum, 18 inch max, thick

F. Do not pile earth or gravel more than 3 feet deep

G. Take special care to prevent damaging or disturbing roofing membrane, the drains, or granular fill material

3.14 BORROW AREA

A. Obtain material required to complete fills and embankments from areas indicated on the drawings or as directed by Engineer

B. The location, size, shape, depth, drainage, and surfacing of borrow pits shall be acceptable to Engineer

C. Make borrow pits regular in shape with graded and surfaced side and bottom slopes when completed

D. Cut side slopes not steeper than 1:1 and uniform for the entire length of any 1 side

E. Final grade disturbed areas of borrow to uniform slope

F. Use material free of debris and deleterious material

3.15 BLASTING

A. Blasting or other use of explosives is not permitted

3.16 TRENCH EXCAVATION

A. Establish alignment and grade or elevation from offset stakes

B. Excavate trenches so pipes can be laid straight at uniform grade without dips or bumps, between the terminal elevations indicated on the Drawings

C. Comply with pipe specification sections regarding vertical and horizontal alignment and max joint deflection

D. Where grades or elevations are not fixed on the Drawings, excavate trenches to provide a minimum depth of backfill cover over the top of pipe:
   1. 24 inches for water piping
   2. Increase depth as required at vertical curves and for clearance beneath existing pipes, conduits, drains, drainage structures, or other obstructions encountered at normal pipe grades

E. Measure pipe cover depth vertically from top of pipe to finished ground or surface elevation

F. Do not open more trench in advance of pipe laying than is necessary to expedite the work; never more than 400 feet

G. Except where tunneling is indicated on the Drawings, specified, or permitted by Engineer, excavate trenches by open cut from the surface

H. Limiting trench widths:
   1. Excavate to a width which will provide adequate working space and pipe clearances for proper pipe installation, jointing, embedment
   2. If needed to reduce earth loads to prevent sliding, cut banks back on slopes which extend to the bottom of the pipe, as identified on drawings
   3. Stipulated minimum clearances are minimum clear distances, not minimum average distances
   4. Max trench width at trench bottom of the installed pipe: Pipe O.D. plus 24 inches
   5. Limiting trench widths and permissible clearances at the bottom of pipe or trench bottom for installed pressure and non-pressure piping

Pipe Size (inch)	Minimum Trench Width	Maximum Trench Width
4	1'-6"	2'-6"
6	1'-6"	2'-6"
8	1'-8"	2"-8"
10	2'-0"	3'-0"
12	2'-0"	3'-0"

I. If the width of the lower portion of the trench exceeds the max permitted, provide pipe of adequate strength, special pipe embedment, or arch concrete encasement as required by loading conditions and as determined by Engineer

J. Mechanical excavation:
   1. Do not use where its operation would damage buildings, culverts, or other existing property, structures, or utilities above or below ground; hand excavate only in such areas
   2. Use mechanical equipment of a type, design, and construction and operated so that:
      a. Rough trench bottom elevation can be controlled
      b. Uniform trench widths and vertical sidewalls are obtained from 1 foot above the top of the installed pipe to the bottom of the trench
      c. Trench alignment is such that pipe is accurately laid to specified alignment and is centered in the trench with adequate clearance between pipe and trench sidewalls
   3. Do not undercut trench sidewalls
   4. Recompact trench bottom disturbed by bucket teeth prior to placement of embedment material

K. Except as otherwise required, excavate trenches below the underside of pipes as indicated in the Drawings to provide for installation of granular or native soil embedment pipe foundation material

L. Where in earth, trench bottoms for 6 inches and smaller pipe may be excavated below pipe subgrade and granular embedment provided or the trench may be graded to provide uniform and continuous support (between bell holes or end joints) of the installed pipe, Engineer's option

M. Whenever so directed by Engineer, excavate to such depth below a grade as Engineer directs and bring the trench bottom to grade with such material as Engineer may direct

N. Provide concrete, or other foundations made necessary by unstable soil as directed by Engineer

O. Excavate to provide adequate clearance for tools and methods of pipe installation

P. Do not allow any of bells or couplings to contact the trench bottom, walls, or granular embedment when pipe is joined

Q. Cuts in surface construction:
   1. No larger than necessary to provide adequate working space
   2. Cut a clean groove not less than 12 inch deep along each side of trench or around perimeter of excavation area
   3. Remove pavement and base pavement to provide shoulder not less than 1 foot wide between cut edge and top edge of trench
   4. Do not undercut trenches, resulting in bottom trench width greater than top widths

5. Make pavement cuts to and between straight or accurately marked curved lines parallel to trench centerline or limits of excavation
6. Remove pavement for connections to existing lines or structures only to the extent required for the installation, as determined by Engineer
7. Where the trench parallels the length of a concrete walk which is all or partially over the trench, remove and replace the entire walk
8. Where the trench crosses the drives, walks, curbs, or other surface construction, remove and replace the surface construction between saw cuts as specified for pavement

3.17 PIPE EMBEDMENT

A. Embed pipes above and below the bottom of pipe as indicated in the Drawings and as specified

B. Spread and surface grade granular or native soil embedment to provide continuous and uniform support beneath pipe at all points between pipe joints

C. After grading, aligning, and placing pipe in final position, and shoring home, deposit and compact sufficient embedment under and around each side of the pipe and to hold the pipe in proper position and alignment during subsequent operations

D. Place and compact embedment material uniformly and simultaneously on both sides of pipe to prevent lateral displacement

E. Granular embedment:
1. Compact by slicing with shovel or vibrating
2. Maximum uncompacted thickness of layers: 6 inch

F. Compacted embedment:
1. Maximum uncompacted thickness of layers: 8 inch
2. Compact to 90 percent max density as determined by ASTM D1557
3. Compact to 70 percent relative density ASTM D4253/D4254

3.18 TRENCH BACKFILL

A. Compacted backfill:
1. For full depth of trench above embedment
2. Beneath pavements, surfacing, driveways, curbs, gutters, walks or other surface construction or structures
3. In street or highway shoulders
4. In established sodded areas
5. Beneath fills and embankments

B. Where the trench for 1 pipe passes beneath the trench of another pipe, compact the backfill for the lower trench to the bottom of the upper trench

C. Place job excavated materials in 8 inch max uncompacted thickness, uniform layers

D. Increased layer thickness may be permitted for uncohesive material if Engineer is satisfied that specified compacted density will be achieved

E. Use methods and equipment appropriate to the material to be compacted to prevent transmission of damaging shocks to pipe

F. Compact to 90% of maximum dry density within ±3% optimum moisture content per ASTM D1557 or to an equivalent percent relative density per ASTM D4253/D4254 when appropriate, unless otherwise directed on drawings

G. Graded gravel:
   1. Deposit in uniform layers of 12 inch max uncompacted thickness
   2. Compact with suitable vibrating roller or platform vibrator to not less than 70 percent relative density per ASTM D4253/D4254

H. Uncompacted backfill:
   1. Compaction of backfill above pipe embedment in locations other than those specified, is required only to prevent future settlement
   2. May be placed by any method acceptable to Engineer which will not impose excessive concentrated or unbalanced loads, shock, or impact on, and will not result in displacement of installed pipe
   3. Do not drop compact masses of stiff clay or other consolidated material more than 5 feet into trench unless cushioned by 2 feet minimum of loose backfill above pipe embedment

3.19 STRUCTURAL BACKFILL

A. Maximum uncompacted thickness of layers: 6 inches

B. Compact with mechanical, platform-type tampers

C. Minimum density of 95% percent within ±2% optimum moisture content as determined by ASTM D1557

D. Use roller for compaction if necessary to prevent damage to structure and desired density can be obtained

E. Compaction by inundation by water not permitted

F. If trench passes through a structure backfill, compact backfill to an elevation of 12 inches above top of pipe before trenching

G. Do not deposit or compact tamped or otherwise mechanically compacted backfill in water

H. Take particular care to compact backfill which will be beneath slabs, pipes, drives, roads, parking areas, curb, gutters or other surface construction

3.20 DRAINAGE MAINTENANCE

A. Do not backfill trenches across roadways, drives, walks or other trafficways adjacent to drainage ditches or water courses prior to backfilling the trench on the upstream side of the trafficway to prevent impounding water after pipe is laid

B. Backfill so that water does not accumulate in unfilled or partially filled trenches

C. Remove materials deposited in roadway ditches or other water courses crossed by the trench line immediately after backfilling is completed and restore ditches and water courses to original section, grade, and contours

D. Do not obstruct surface drainage any longer than necessary

E. Provide and maintain temporary bridges and other structures across unfilled trenches as required to maintain traffic

3.21 PROTECTION OF TRENCH BACKFILL

A. Where trenches are constructed in ditches or other water courses, protect backfill from erosion

B. Install ditch checks where the ditch grade exceeds 1 percent:
   1. Minimum depth: 2 feet below the original ditch or water course bottom for the full bottom width
   2. Minimum width: 18 inches into the side slopes
   3. Minimum thickness: 12 inches

3.22 DISPOSAL OF EXCESS EXCAVATED MATERIALS

A. Use excess excavated materials in fills and embankments as indicated on the Drawings to the extent needed

B. Dispose of suitable excess excavated materials at locations on the site directed by Engineer

C. Remove unused suitable material from the site and dispose of it

D. Remove debris, junk, broken concrete, broken asphalt, rock, stones, stumps, logs, roots, and other unsuitable material from the site and dispose of it

E. Except as otherwise permitted, dispose of excess excavated materials away from the site of the Work or as directed by Engineer

F. Distribute excess earth from excavations located in unimproved property directly over the pipe trench and within the pipeline right-of-way to a max depth of 6 inch above the original ground surface elevation at and across the trench and sloping uniformly each way:
   1. Carefully finish material thus wasted with a drag, blade machine, or other suitable tool to a smooth, uniform surface without obstructing drainage at any point
   2. Do not waste excess excavated material in the above manner where the trench lines crosses or is within a railroad, public road, or highway right-of-way

3.23 FINAL GRADING

A. After completion of all other outside work and after backfilling is completed and settled, bring to grade at the indicated elevations

B. Graders and other power equipment may be used for final grading and slope dressing if the result is uniform and equivalent to hand work

C. Grade all surfaces for effective drainage

D. Provide a 2 percent minimum slope except as otherwise required

E. Grade and surface to maintain gradient as indicated

3.24 SLOPE STABILIZATION

A. Cover slopes with erosion control fabric where grade is 2H to 1V or greater and where indicated on the Drawings

B. Lay fabric smoothly on surface, bury top end of each section in 6-inch deep excavated topsoil trench. Provide 6-inch overlap minimum of adjacent rolls. Backfill trench and rake smooth, level with adjacent soil

C. Secure outside edges and overlaps at 48 inch intervals with 4-inch to 6-inch U-shaped type pins or wooden stakes depending on ground condition

D. Lightly dress slopes with topsoil to ensure close contact between fabric and soil

E. At sides of ditches, lay fabric laps in direction of water flow. Lap ends and edges minimum 6 inches

3.25 STRAW BALE EROSION CONTROL BARRIERS

A. Place straw bale erosion control barriers where required and where directed by the Engineer

B. Field locate straw bales along slopes, next to water courses and downstream of disturbed areas to prevent surface runoff from eroding areas disturbed by General Contractor during construction, to minimize the transport of suspended solids downstream or into adjacent streams, canals or ditches and to protect newly seeded areas

C. Install each bale with wire binding oriented around the bale rather than on top of the bale. Stake each bale twice with reinforcing steel or wood stakes deep enough into the ground to securely anchor the bale

D. Maintain and replace bales as required for an effective erosion control barrier until satisfactory uniform plant growth is established as defined herein

3.26 STORMWATER MANAGEMENT PLAN

A. Engineer shall submit General Permit Application for stormwater discharges associated with construction activity and comply with all conditions of the permit

B. General Contractor-shall comply with the Engineer's Stormwater Management Plan for this project.

3.27 SETTLEMENT

A. Warranty for settlement of all fills, embankments, and backfills is stipulated in the General Conditions from final completion of Contract under which Work is performed

B. Repair or replace within 30 days after notice by Engineer.

3.28 FIELD QUALITY CONTROL

A. Provide under provisions of Section 01400

B. Coordinate and pay for all tests to determine compliance of in-place and backfill materials and compaction in accordance with the specifications

END OF SECTION

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SPECIFICATION REVISION INDEX

Revision No.	Revision Date	Issued for	Signatures				
			Prepared By	Reviewed By	Project Engineer	Project Manager	Client
A	11/28/2016	60% Submittal	CMF	JG	JG	STD	
B	2/15/2017	75% Submittal	CMF	JG	JG	STD	

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SECTION 02210

SITE GRADING

PART 1 GENERAL

1.01 DESCRIPTION:

A. Scope of Work: The work in this section consists of furnishing all necessary labor, equipment, material necessary to bring the project site to the lines and grades shown on the Drawings.

B. The General Contractor must determine for himself the volume of material required for the site.

C. Definitions:

1. Open Areas: Open areas shall be those areas that do not include building sites, aggregate areas, access road right-of-way and parking areas.

2. Maximum Density: Maximum weight in pounds per cubic foot (pcf) of a specific material.

3. Optimum Moisture: Percentage of water in a specific material at maximum density.

4. Rock Excavation: Excavation of any hard natural substance which requires the use of special impact tools such as, jackhammers, sledges, chisels, or other similar devices specifically designed for use is cutting or breaking rock, but exclusive of trench excavating machinery.

D. Related Work Described Elsewhere:

1. Backfill: Section 02220.

1.02 SUBMITTALS:

A. Submit three (3) copies and one electronic copy of the report from the testing laboratory verifying that off-site borrow material conforms to the gradation specified.

1.03 TESTING REQUIREMENTS:

A. Determination of laboratory moisture-density relationship and maximum density shall be in according to AASHTO T 99, AASHTO T 272. At least one (l) test per soil type shall be made.

B. In place compaction test shall be performed according to Nevada DOT Supplement 1015. In place field densities shall be taken at one (l) every 5,000 square feet and at not greater than 1 foot vertical intervals for all fill areas under structures and pavement. One (l)

density test is required for each pad or isolated footing and for every 20 linear feet of strip/wall footing length.

C. Compaction shall be deemed to comply with the Specifications when no tests fall below the specified relative compaction. The General Contractor shall pay the costs of any retesting of work no conforming to the Specifications.

D. Relative compaction is defined as the ratio, expressed as a percentage, of the in-place density to the laboratory maximum density.

E. Density tests will be made for determination of specified compaction by an independent testing laboratory provided by the General Contractor as approved by the Engineer. Tests will be made in locations reviewed and approved by the Engineer. If any tests are unsatisfactory, re-excavate and recompact the fill or backfill until the specified compaction is obtained. Additional compaction tests will be taken to each side of an unsatisfactory test at locations approved by the Engineer to determine the extent of re-excavation and recompaction necessary.

PART 2 PRODUCTS

2.01 MATERIALS:

A. Suitable: All suitable materials are restricted in Nevada DOT specification 203.03. Furnish soil or embankment material conforming to Nevada DOT specification 703.16, when Nevada DOT specification 203 Embankment is specified. Furnish material that conforms to 703.16.B or 703.16.C when Nevada DOT specification 203 Granular Embankment is specified. Furnish material that conforms to 703.16.C when Nevada DOT specification 203 Granular Material Types A, B, C, D, E or F are specified. Do not use recycled materials unless specifically allowed by the Supplemental Specifications.

D. Water for Compaction: Water shall be free of acid, alkali, or organic materials and shall have a pH of 7.0 to 9.0, a maximum chloride concentration of 500 mg/l, and a maximum sulfate concentration of 500 mg/l. Provide all water needed for earthwork. Provide temporary piping and valves to convey water from the source to the point of use. Provide any meters if the water is taken from a water district or agency pipeline.

PART 3 EXECUTION

3.01 PERFORMANCE:

A. Unless otherwise specified or shown on the Drawings, compact fill, embankments, and backfills to 95 percent (95%) Modified Proctor Density.

B. Excavation:

1. Excavation shall conform to the limits indicated on the plans or specified herein. This work shall included shaping and sloping and other work necessary in bringing the earthwork to the required grade, alignment and cross section.

2. All suitable materials removed from the excavation shall be used as far as practicable in the formation of the embankments, subgrades, shoulders, building sites and other places as directed. No excavated material shall be wasted without permission, and where necessary to waste much material it shall be at the direction of the Engineer. Unsuitable material shall be removed to the required depth and replaced to the satisfaction of the Engineer with suitable material. Unsuitable material existing in open areas may remain, and these open areas may be used for disposal areas for the unsuitable material as directed by the Engineer.

C. Fills:

1. Fills shall be formed of suitable material placed in layers of not more than 8 inches in depth measured loose and rolled and/or vibrated with suitable equipment until compacted. Thickness of layers may be increased provided the equipment and methods used are proven by field density testing to be capable of compacting thicker layers to specified densities. Layer thickness shall be decreased if equipment and methods used are proven to be incapable of compacting the layers to specified densities.

2. Rock that will not pass through a 6 inch diameter ring shall not be placed within the top 12 inches of the surface of the completed fill. Rock that will not pass through a 3 inch diameter ring shall not be placed within the top 4 inches of the completed fill. Broken concrete or asphaltic pavement shall not be used in fills.

3. Final elevations shall be within 0.1 foot of the required elevation and surfaces shall be sloped to drain as shown on the Drawings

D. Excess excavation of suitable materials shall become, unless otherwise noted, the property of the Engineer and shall be disposed of on-site at an area to be determined by the Engineer. The Engineer may elect to not keep the material in which case the General Contractor shall make arrangements and bear all cost of disposing the material off-site. All unsuitable excess material shall be disposed off-site by the General Contractor.

E. Moisture Control of Earth Material: During the compaction operations, maintain optimum practicable moisture content required for compaction purposes in each lift of the material. Maintain moisture content uniform throughout the lift. Insofar as practicable, add water to the material at the site of excavation. Supplement by sprinkling the material. At the time of compaction, the water content of the material shall be at optimum water content or within 2 percentage points above optimum. Aerate material containing excessive moisture by blading, discing, or harrowing to hasten the drying process.

END OF SECTION

SPECIFICATION REVISION INDEX

Revision No.	Revision Date	Issued for	Signatures				
			Prepared By	Reviewed By	Project Engineer	Project Manager	Client
A	11/28/2016	60% Submittal	CMF	JG	JG	STD	
B	2/15/2017	75% Submittal	CMF	JG	JG	STD	

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SECTION 02224

SUBGRADE PREPARATION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Compaction, moisture conditioning and testing.

1.2 RELATED SECTIONS

A. Section 01400 – Quality Control

B. Section 01450 – Special Inspection and Testing

C. Section 02200 – Earthwork

D. Section 02372 – HDPE Geomembrane Liner

E. *Report of Geotechnical Investigation, Weir Dewatering Treatment, Central Water Treatment Plant, Nevada Environmental Response Trust, Henderson, Nevada,* Tetra Tech, February 14, 2017.

F. *Report of Geotechnical Investigation, Weir Dewatering Treatment, Pump Stations, Nevada Environmental Response Trust, Henderson, Nevada,* Tetra Tech, February 14, 2017.

1.3 DEFINITIONS

A. Prepared Ground Surface: Ground surface after completion of clearing and grubbing, stripping of topsoil, excavation to subgrade, and scarification and compaction of subgrade.

B. Subgrade: Layer of existing soil after completion of clearing, grubbing, scalping of topsoil and excavation prior to placement of fill, base materials, geomembrane liner, roadway structure or base for floor slab.

C. Proof-Rolling: Testing of subgrade by compactive effort to identify areas that will not support the future loading without excessive settlement.

1.4 QUALITY ASSURANCE

A. Notify Engineer when subgrade is ready for compaction testing or proof-rolling or whenever compaction or proof-rolling is resumed after a period of extended inactivity.

1.5 ENVIRONMENTAL REQUIREMENTS

A. Prepare subgrade when unfrozen and free of ice and snow.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 GENERAL

A. Keep subgrade free of water, debris, and foreign matter during compaction and proof-rolling.

B. Bring subgrade to proper grade and cross-section and uniformly compact surface.

C. Do not use sections of prepared ground surface as haul roads. Protect prepared subgrade from traffic.

D. Maintain prepared ground surface in finished condition until next course is placed.

3.2 COMPACTION

A. Under Earthfill: Compact subgrade to a minimum 95% of the soil maximum dry density as determined by ASTM D1557, and per the recommendations in the *Report of Geotechnical Investigation, Weir Dewatering Treatment, Central Water Treatment Plant, Nevada Environmental Response Trust, Henderson, Nevada,* Tetra Tech, dated February 14, 2017, and *Report of Geotechnical Investigation, Weir Dewatering Treatment, Pump Stations, Nevada Environmental Response Trust, Henderson, Nevada,* Tetra Tech, dated February 14, 2017.

B. Under Tank Foundations: Compact subgrade to a minimum of 95% of the soil maximum dry density as determined by ASTM D1557, and per the recommendations in the *Report of Geotechnical Investigation, Weir Dewatering Treatment, Central Water Treatment Plant, Nevada Environmental Response Trust, Henderson, Nevada,* Tetra Tech, dated February 14, 2017, and *Report of Geotechnical Investigation, Weir Dewatering Treatment, Pump Stations, Nevada Environmental Response Trust, Henderson, Nevada,* Tetra Tech, dated February 14, 2017.

C. Under Pavement Structure, Floor Slabs On Grade, or Granular Fill Under Structures: Compact subgrade to a minimum of 95% of the soil maximum dry density as determined by ASTM D1557, and per the recommendations in the *Report of Geotechnical Investigation, Weir Dewatering Treatment, Central Water Treatment Plant, Nevada Environmental Response Trust, Henderson, Nevada*, Tetra Tech, dated February 14, 2017, and *Report of Geotechnical Investigation, Weir Dewatering Treatment, Pump Stations, Nevada Environmental Response Trust, Henderson, Nevada*, Tetra Tech, dated February 14, 2017.

3.3 MOISTURE CONDITIONING

A. Dry Subgrade: Add water, then mix to make moisture content uniform throughout.

B. Wet Subgrade: Aerate material by blading, dicing, harrowing, or other methods, to hasten drying process.

C. Subgrade used for structural fill shall have moisture content within ±2% of optimum and be compacted per Section 3.2 of this Specification.

D. Subgrade shall be compacted at or above the optimum moisture content of the soil in order to assist with hydrating of the geomembrane liner.

3.4 TESTING

A. Test compaction under provisions of Sections 01400 and 01450.

B. Proof-roll Subgrade with equipment specified in Section 3.2 of this Specification, to detect soft or loose Subgrade or unsuitable material.

3.5 CORRECTION

A. Correct soft or loose Subgrade detected during proof-rolling:
   1. Adjust moisture content and re-compact, or
   2. Over excavate loose materials and replace with suitable material from the excavation.

B. Unsuitable Material: Over excavate and replace with suitable material from the excavation.

3.6 ACCEPTANCE

A. Do not place fill, pavement, tank concrete ringwall foundation, geomembrane liner, or structures on Subgrade until the Engineer has accepted the Subgrade as suitable.

END OF SECTION

SPECIFICATION REVISION INDEX

Revision No.	Revision Date	Issued for	Signatures				
			Prepared By	Reviewed By	Project Engineer	Project Manager	Client
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SECTION 02372

HDPE GEOMEMBRANE LINER

PART 1: GENERAL

1.1 SUMMARY

A. This specification includes furnishing and installing HDPE geomembrane with a formulated sheet density of 0.940 g/cc or greater. Geomembrane shall be smooth.

1.2 RELATED SECTIONS

A. Section 02224 – Subgrade Preparation
B. Section 02777 – Geomembrane Leak Location Survey

1.3 REFERENCES

A. American Society for Testing and Materials (ASTM):
   1. D 638, Standard Test Method for Tensile Properties of Plastics.
   2. D 751, Standard Test Methods for Coated Fabrics.
   3. D 792, Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
   4. D 1004, Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting.
   5. D 1204, Standard Test Method for Linear Dimensional Changes of Non Rigid Thermoplastic Sheeting or Film at Elevated Temperature.
   6. D 1238, Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.
   7. D 1505, Standard Test Method for Density of Plastics by Density-Gradient Technique.
   8. D 1603, Standard Test Method for Carbon Black in Olefin Plastics.
   9. D 3895, Test Method for Oxidative Induction Time of Polyolefins by Thermal Analysis.
   10. D 4218, Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique.
   11. D 4437, Standard Practice for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Sheet Geomembranes.
   12. D 4833, Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products.
   13. D 5199, Standard Test Method for Measuring Nominal Thickness of Smooth Geomembranes.
   14. D 5397, Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefins using Notched Constant Tensile Load Test.
   15. D 5596, Standard Practice for Microscopical Examination of Pigment Dispersion in Plastic Compounds.
   16. D 5641, Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber.

17. D 5721, Practice for Air-Oven Aging of Polyolefin Geomembranes.
18. D 5820, Test Method for Air Testing.
19. D 5885, Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High Pressure Differential Scanning Calorimetry.
20. D 5994, Standard Test Method for Measuring Nominal Thickness of Textured Geomembranes
21. D 6365, Standard Practice for the Nondestructive Testing of Geomembrane Seams using The Spark Test

B. Geosynthetic Research Institute (GRI):
1. GRI GM 6, Pressurized Air Channel Test for Dual Seamed Geomembranes
2. GRI GM 9, Cold Weather Seaming of Geomembranes
3. GRI GM 10, Specification for Stress Crack Resistance of HDPE Geomembrane Sheet
4. GRI GM 13, Test Properties, Testing Frequency and Recommended Warranty for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes
5. GRI GM 14, Test Frequencies for Destructive Seam Testing

1.4 SUBMITTALS

A. Submit under provisions of Section 01330, Shop Drawings, Product Data, and Samples.

B. Submit the following to the Engineer, for review and approval, within a reasonable time so as to expedite shipment or installation of the Geomembrane:
1. Documentation of manufacturer's qualifications as specified in subsection 1.5A of this Section.
2. Manufacturer's Quality Control program manual or descriptive documentation.
3. A material properties sheet, including at a minimum all properties specified in GRI GM 13, including test methods used.
4. Sample of the material.
5. Documentation of Installer's qualifications, as specified below and in subsection 1.5B of this Section.
   a. Submit a list of at least ten completed facilities. For each installation, provide: name and type of facility; its location; the date of installation; name and telephone number of contact at the facility; type and thickness of geomembrane and; surface area of the installed geomembrane.
   b. Submit resumes or qualifications of the Installation Supervisor, Master Seamer and Technicians to be assigned to this project.
   c. Quality Control Program.
6. Material Warranty and Liner Installation Warranty complying with subsections 1.8 and 1.9 of this Section.
7. Resin Supplier's name, resin production plant identification, resin brand name and number, production date of the resin, resin Manufacturer's quality control certificates, and certification that the properties of the resin meet the requirements for the project.

C. Shop Drawings
1. Submit copies of shop drawings for Engineer's approval within a reasonable time so as not to delay the start of geomembrane installation. Shop drawings shall show the proposed panel layout identifying seams and details. Seams should generally follow the direction of the slope. Butt seams or roll-end seams should not occur on a slope

unless approved by the Engineer. Butt seams on a slope, if allowed, should be staggered.

2. Placement of geomembrane will not be allowed to proceed until Engineer has received and approved the shop drawings.

D. Additional Submittals (In-Progress and at Completion)
   1. Manufacturer's warranty (refer to subsection 1.8).
   2. Geomembrane installation warranty (refer to subsection 1.9).
   3. Daily written acceptance of subgrade surface (refer to subsection 3.1.C).
   4. Low-temperature seaming procedures if applicable (refer to subsection 3.3.A).
   5. Prequalification test seam samples (refer to subsection 3.5.A.6).
   6. Field seam non-destructive test results (refer to subsection 3.5.B.1).
   7. Field seam destructive test results (refer to subsection 3.5.D.6).
   8. Daily field installation reports (refer to subsection 3.5.H).
   9. Installation record drawing, as discussed in subsection 3.5.

1.5 QUALITY CONTROL

A. Manufacturer's Qualifications: The manufacturer of geomembrane of the type specified or similar product shall have at least five years experience in the manufacture of such geomembrane. In addition, the geomembrane manufacturer shall have manufactured at least 10,000,000 square feet of the specified type of geomembrane or similar product during the last five years.

B. Installer's Qualifications
   1. The Geomembrane Installer shall be the Manufacturer, approved Manufacturer's Installer or a Sub-Contractor approved by the Engineer to install the geomembrane.

   2. The Geomembrane Installer shall have at least three years experience in the installation of the specified geomembrane or similar. The Geomembrane Installer shall have installed at least 10 projects involving a total of 5,000,000 square feet of the specified type of geomembrane or similar during the last three years.

   3. Installation shall be performed under the direction of a field Installation Supervisor who shall be responsible throughout the geomembrane installation, for geomembrane panel layout, seaming, patching, testing, repairs, and all other activities of the Geomembrane Installer. The Field Installation Supervisor shall have installed or supervised the installation and seaming of a minimum of 10 projects involving a total of 5,000,000 square feet of geomembrane of the type specified or similar product.

   4. Seaming shall be performed under the direction of a Master Seamer (who may also be the Field Installation Supervisor or Crew Foreman) who has seamed a minimum of 3,000,000 square feet of geomembrane of the type specified or similar product, using the same type of seaming apparatus to be used in the current project. The Field Installation Supervisor and/or Master Seamer shall be present whenever seaming is performed.

   5. All seaming, patching, other welding operations, and testing shall be performed by qualified technicians employed by the Geomembrane Installer.

1.6 DELIVERY, STORAGE AND HANDLING

A. Each roll of geomembrane delivered to the site shall be labeled by the manufacturer. The label shall be firmly affixed and shall clearly state the manufacturer's name, product identification, material thickness, roll number, roll dimensions and roll weight.

B. Geomembrane shall be protected from mud, dirt, dust, puncture, cutting or any other damaging or deleterious conditions.

C. Rolls shall be stored away from high traffic areas. Continuously and uniformly support rolls on a smooth, level prepared surface.

D. Rolls shall not be stacked more than three high.

1.7 PROJECT CONDITIONS

A. Geomembrane should not be installed in the presence of standing water, while precipitation is occurring, during excessive winds, or when material temperatures are outside the limits specified in Section 3.3.

1.8 MATERIAL WARRANTY

A. The geomembrane manufacturer shall warrant their materials for a minimum of five (5) years.

1.9 GEOMEMBRANE INSTALLATION WARRANTY

A. The Geomembrane Installer shall guarantee the geomembrane installation against defects in the installation and workmanship for 1 year commencing with the date of final acceptance.

1.10 GEOMEMBRANE PRE-CONSTRUCTION MEETING

A. A Geomembrane Pre-Construction Meeting shall be held at the site prior to installation of the geomembrane. At a minimum, the meeting shall be attended by the Geomembrane Installer, General Contractor and Engineer.

B. Topics for this meeting shall include:
   1. Responsibilities of each party.
   2. Lines of authority and communication. Resolution of any project document ambiguity.
   3. Methods for documenting, reporting and distributing documents and reports.
   4. Procedures for packaging and storing archive samples.
   5. Review of time schedule for all installation and testing.
   6. Review of panel layout and numbering systems for panels and seams including details or marking on geomembrane.
   7. Procedures and responsibilities for preparation and submission of as-built panel and seam drawings.
   8. Temperature and weather limitations. Installation procedures for adverse weather conditions. Defining acceptable subgrade, geomembrane, or ambient moisture and temperature conditions for working during liner installation. Installation limitations under specific wind conditions shall be discussed.

9. Subgrade conditions, dewatering responsibilities and subgrade maintenance plan.
10. Deployment techniques including allowable subgrade for the geomembrane.
11. Plan for controlling expansion/contraction and wrinkling of the geomembrane.
12. Covering of the geomembrane and cover soil placement.
13. Health and safety.
14. Testing program.

C. The meeting shall be documented by a person designated at the beginning of the meeting and minutes shall be transmitted to all parties.

PART 2: PRODUCTS

2.1 SOURCE QUALITY CONTROL

A. Manufacturing Quality Control

1. The test methods and frequencies used by the manufacturer for quality control/quality assurance of the above geomembrane prior to delivery, shall be in accordance with GRI GM 13, or modified as required for project specific conditions.

2. The manufacturer's geomembrane quality control certifications, including results of quality control testing of the products, as specified in subsection 2.1.A.3 of this Section, must be supplied to the Engineer to verify that the materials supplied for the project are in compliance with all product and or project specifications in this Section. The certification shall be signed by a responsible party employed by the manufacturer, such as the QA/QC Manager, Production Manager, or Technical Services Manager. Certifications shall include lot and roll numbers and corresponding shipping information.

3. The Manufacturer will provide Certification that the geomembrane and welding rod supplied for the project have the same base resin and material properties.

2.2 GEOMEMBRANE

A. The geomembrane shall consist of new, first quality products designed and manufactured specifically for the purpose of this work which shall have been satisfactorily demonstrated by prior testing to be suitable and durable for such purposes. The geomembrane rolls shall be seamless, high density polyethylene (HDPE Density > 0.94g/cc) containing no plasticizers, fillers or extenders and shall be free of holes, blisters or contaminants, and leak free verified by 100% in line spark or equivalent testing. The geomembrane shall be supplied as a continuous sheet with no factory seams in rolls. The geomembrane shall meet the property requirements as shown in GRI GM 13.

B. Material conformance testing by the Construction Manager, if required, will be conducted in accordance with the project specifications.

C. The geomembrane seams shall meet the property requirements as shown in Table 2, (Attachment B) or as required by project specifications.

D. The geomembrane shall be 60 mil HDPE smooth on both sides as manufactured by POLY-FLEX, Grand Prairie, Texas or Engineer pre-approved equal. Prior to using an alternative geomembrane, the Contractor shall furnish to the Engineer independent test results demonstrating that the alternative material meets the requirements of this Specifications.

2.3 WELDING ROD

A. The welding rod shall have the same properties as the resin used to manufacture the geomembrane.

2.4 CONCRETE EMBEDMENT STRIP

A. The concrete embedment strip shall be high density polyethylene (HDPE, Density ≥ 0.94 g/cc). The material, including the resin and carbon black content, shall have the same properties used to manufacture the HDPE geomembrane. The concrete embedment strip shall have the dimensions and installed as shown on the Drawings. The concrete embedment strips shall be installed in strict conformity with all applicable instructions and recommendations of the manufacturer to secure a seal. The concrete embedment strip shall be GSE PolyLock or equivalent.

PART 3: EXECUTION

3.1 SUBGRADE PREPARATION

A. The subgrade shall be prepared in accordance with Section 02224 – Subgrade Preparation. The geomembrane subgrade shall be uniform and free of all sharp or angular objects that may damage the geomembrane prior to installation of the geomembrane.

B. The Geomembrane Installer, General Contractor, and Engineer shall inspect the surface to be covered with the geomembrane on each day's operations prior to placement of geomembrane to verify suitability.

C. The Geomembrane Installer, General Contractor, and Engineer shall provide daily written acceptance for the surface to be covered by the geomembrane in that day's operations. The surface shall be maintained in a manner, during geomembrane installation, to ensure subgrade suitability.

D. All subgrade damaged by construction equipment and deemed unsuitable for geomembrane deployment shall be repaired prior to placement of the geomembrane. All repairs shall be approved by the Engineer and the Geomembrane Installer. This damage, repair, and the responsibilities of the General Contractor and Geomembrane Installer shall be defined in the preconstruction meeting.

3.2 GEOMEMBRANE PLACEMENT

A. No geomembrane shall be deployed until the applicable certifications and quality control certificates listed in subsection 1.4 of this Section are submitted to and approved by the Engineer. Should geomembrane material be deployed prior to approval by the Engineer it will be at the sole risk of the Geomembrane Installer. If the material does not meet project specifications it shall be removed from the work area at no cost to the Owner.

B. The geomembrane shall be installed to the limits shown on the project drawings and essentially as shown on approved panel layout drawings.

C. No geomembrane material shall be unrolled and deployed if the material temperatures are lower than 0 degrees C (32 degrees F) unless otherwise approved by the Engineer. The specified minimum temperature for material deployment may be adjusted by the Engineer based on recommendations by the manufacturer. Temperature limitations should be defined in the preconstruction meeting. Typically, only the quantity of geomembrane that will be anchored and seamed together in one day should be deployed.

D. No vehicular traffic shall travel on the geomembrane other than an approved low ground pressure All Terrain Vehicle or equivalent.

E. Sand bags or equivalent ballast shall be used as necessary to temporarily hold the geomembrane material in position under the foreseeable and reasonably expected wind conditions. Sand bag material shall be sufficiently close-knit to prevent soil fines from working through the bags and discharging on the geomembrane.

F. Geomembrane placement shall not be done if moisture prevents proper subgrade preparation, panel placement, or panel seaming. Moisture limitations should be defined in the preconstruction meeting.

G. Damaged panels or portions of the damaged panels which have been rejected shall be marked and their removal from the work area recorded.

H. The geomembrane shall not be allowed to "bridge over" voids or low areas in the subgrade. In these areas, the subgrade shall be regraded to allow the geomembrane to rest in intimate contact with the subgrade.

I. Wrinkles caused by panel placement or thermal expansion should be minimized in accordance with section 1.10.B11.

J. Considerations on Site Geometry: In general, seams shall be oriented parallel to the line of the maximum slope. In corners and odd shaped geometric locations, the total length of field seams shall be minimized. Seams shall not be located at low points in the subgrade unless geometry requires seaming at such locations and is approved by the Engineer.

K. Overlapping: The panels shall be overlapped prior to seaming to whatever extent is necessary to affect a good weld and allow for proper testing. In no case shall this overlap be less than 75mm (3 in.).

L. Temperature Effects on Geomembrane – Expansion/Contraction

1. Sufficient slack shall be placed in the geomembrane to compensate for the coldest temperatures envisioned, so that no tensile stresses are generated in the geomembrane or in its seams either during installation or subsequently after the geomembrane is covered.
2. The geomembrane shall have adequate slack such that it does not lift up off of the subgrade or substrate material at any location within the facility, i.e., no “trampolining” of the geomembrane shall be allowed to occur at any time.

3. The geomembrane shall not have excessive slack to the point where creases fold over upon themselves either during placement and seaming, or when the protective soil or drainage materials are placed on geomembrane.
4. Permanent creases in the covered geomembrane shall not be permitted at any time.

3.3 SEAMING PROCEDURES

A. Cold weather installations should follow guidelines as outlined in GRI GM9.

B. No geomembrane material shall be seamed when liner temperatures are less than 0 degrees C (32 degrees F) unless the following conditions are complied with:

1. Seaming of the geomembrane at material temperatures below 0 degrees C (32 degrees F) is allowed if the Geomembrane Installer can demonstrate to the Engineer, using pre-qualification test seams, that field seams comply with the project specifications, the safety of the crew is ensured, and geomembrane material can be fabricated (i.e. pipeboots, penetrations, repairs. etc.) at sub-freezing temperatures.

2. The Geomembrane Installer shall submit to the Engineer for approval, detailed procedures for seaming at low temperatures, possibly including the following:
   a. Preheating of the geomembrane
   b. The provision of a tent or other device if necessary to prevent heat losses during seaming and rapid heat losses subsequent to seaming.
   c. Number of test welds to determine appropriate seaming parameters

C. No geomembrane material shall be seamed when the sheet temperature is above 75 degrees C (170 degrees F) as measured by an infrared thermometer or surface thermocouple unless otherwise approved by the Engineer. This approval will be based on recommendations by the manufacturer and on a field demonstration by the Geomembrane Installer using prequalification test seams to demonstrate that seams comply with the specification.

D. Seaming shall primarily be performed using automatic fusion welding equipment and techniques. Extrusion welding shall be used where fusion welding is not possible such as at pipe penetrations, patches, attachment to concrete embedment strips, repairs and short (less than a roll width) runs of seams, or as shown on the Drawings.

E. Fishmouths or excessive wrinkles at the seam overlaps shall be minimized and when necessary cut along the ridge of the wrinkles back into the panel so as to effect a flat overlap. The cut shall be terminated with a keyhole cut (nominal 10 mm (1/2 in) diameter hole) so as to minimize crack/tear propagation. The overlay shall subsequently be seamed. The keyhole cut shall be patched with an oval or round patch of the same base geomembrane material extending a minimum of 150 mm (6 in.) beyond the cut in all directions.

F. Excessive grinding of the geomembrane panel in preparation for seaming shall not be acceptable. Excessive grinding shall be considered extensive scoring of the geomembrane panel or when noticeable grinding is observed more than 1/4-inch outside of the completed weld area.

G. All extrusion welding machines that are used shall be purged of old extrudate prior to the start of each weld run. Any extrusion welding machines that are used shall be required to continuously monitor and control the temperatures of the extrudate and the zone of contact to stay within the recommendations of the Geomembrane Manufacturer.

H. Excessive overheating of the geomembrane shall not be permitted. Excessive overheating includes, but is not limited to: 1) Seaming temperature or seaming rates that cause deformation or visible warping of the top or bottom surface of the geomembrane seam area 2) Seaming temperatures in excess of the recommendations of the Geomembrane Manufacturer.

3.4 PIPE AND STRUCTURE PENETRATION SEALING SYSTEM

A. Provide penetration sealing system as shown in the Project Drawings.

B. Penetrations shall be constructed from the base geomembrane material, flat stock, prefabricated boots and accessories as shown on the Project Drawings. The pre-fabricated or field fabricated assembly shall be field welded to the geomembrane as shown on the Project Drawings so as to prevent leakage. This assembly shall be tested as outlined in section 3.5.B. Alternatively, where field seam non-destructive testing cannot be performed, attachments will be field spark tested by standard holiday leak detectors in accordance with ASTM D6365. Spark testing should be done in areas where both air pressure testing and vacuum testing are not possible.

1. Equipment for Spark testing shall be comprised of but not limited to: A hand held holiday spark tester and conductive wand that generates a high voltage.

2. The testing activities shall be performed by the Geomembrane Installer by placing an electrically conductive tape or wire beneath the seam prior to welding. A trial seam containing a non welded segment shall be subject to a calibration test to ensure that such a defect (non welded segment) will be identified under the planned machine settings and procedures. Upon completion of the weld, enable the spark tester and hold approximately 25mm (1 in) above the weld moving slowly over the entire length of the weld in accordance with ASTM D6365. If there is no spark, the weld is considered to be leak free.

3. A spark indicates a hole in the seam. The faulty area shall be located, repaired and retested by the Geomembrane Installer.

4. Care should be taken if flammable gases are present in the area to be tested.

3.5 FIELD QUALITY CONTROL

The Engineer shall be notified prior to all pre qualification and production welding and testing, or as agreed upon in the pre construction meeting.

A. Prequalification Test Seams

1. Test seams shall be prepared and tested by the Geomembrane Installer to verify that seaming parameters (speed, temperature and pressure of welding equipment) are adequate.

2. Test seams shall be made by each welding technician and tested in accordance with ASTM D 4437 at the beginning of each seaming period. Test seaming shall be performed under the same conditions and with the same equipment and operator combination as production seaming. The test seam shall be approximately 3.3 meters (10 feet) long for fusion welding and 1 meter (3 feet) long for extrusion welding with the seam centered lengthwise. The Geomembrane Installer shall perform a test weld for each welder whenever any of the following conditions occur; at shift start-up, during a "cold" restart of the welder, after a change in the welding technician, after a significant change in ambient temperatures, after four (4) hours of continuous operation, or as required by the Engineer. All test seams shall be performed with the same generator unit, lengths of extension cord, and other necessary equipment as proposed for use with each welding unit during the production seaming.

3. Two 25 mm (1 in) wide specimens shall be die-cut by the Geomembrane Installer from each end of the test seam. These specimens shall be tested by the Geomembrane Installer using a field tensiometer testing both tracks for peel strength and also for shear strength. Each specimen shall fail in the parent material and not in the weld, "Film Tear Bond"(F.T.D. failure). Seam separation equal to or greater than 10% of the track width shall be considered a failing test.

4. The minimum acceptable seam strength values to be obtained for all specimens tested are listed in Subsection 3.5.D.4 of this Section. All four specimens shall pass for the test seam to be a passing seam.

5. If a test seam fails, an additional test seam shall be immediately conducted. If the additional test seam fails, the seaming apparatus shall be rejected and not used for production seaming until the deficiencies are corrected and a successful test seam can be produced.

6. A sample from each test seam shall be labeled. The label shall indicate the date, geomembrane temperature, number of the seaming unit, technician performing the test seam and pass or fail description. The sample shall then be given to the Engineer for archiving.

B. Field Seam Non-destructive Testing

1. All field seams shall be non-destructively tested by the Geomembrane Installer over the full seam length before the seams are covered. Each seam shall be numbered or otherwise designated. The location, date, test unit, name of tester and outcome of all non-destructive testing shall be recorded and submitted to the Engineer.

2. Testing should be done as the seaming work progresses, not at the completion of all field seaming, unless agreed to in advance by the Engineer. All defects found during testing shall be numbered and marked immediately after detection. All defects found should be repaired, retested, and remarked to indicate acceptable completion of the repair.

3. Non-destructive testing shall be performed using vacuum box, air pressure, or spark testing equipment.

4. Non-destructive tests shall be performed by experienced technicians familiar with the specified test methods. The Geomembrane Installer shall demonstrate to the Engineer all test methods to verify the test procedures are valid.

5. Extrusion seams shall be vacuum box tested by the Geomembrane Installer in accordance with ASTM D 4437 and ASTM D 5641 with the following equipment and procedures:
   a. Equipment for testing extrusion seams shall be comprised of but not limited to: a vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft rubber gasket attached to the base, port hole or valve assembly and a vacuum gauge; a vacuum pump assembly equipped with a pressure controller and pipe connections; a rubber pressure/vacuum hose with fittings and connections; a plastic bucket; wide paint brush or mop; and a soapy solution.
   b. The vacuum pump shall be charged and the tank pressure adjusted to approximately 35 kPa (5 psig).
   c. The Geomembrane Installer shall create a leak tight seal between the gasket and geomembrane interface by wetting a strip of geomembrane approximately 0.3m (12 in) by 1.2m (48 in) (length and width of box) with a soapy solution, placing the box over the wetted area, and then compressing the box against the geomembrane. The Geomembrane Installer shall then close the bleed valve, open the vacuum valve, maintain initial pressure of approximately 35 kPa (5 psig) for approximately 5 seconds. The geomembrane should be continuously examined through the viewing window for the presence of soap bubbles, indicating a leak. If no bubbles appear after 5 seconds, the area shall be considered leak free. The box shall be depressurized and moved over the next adjoining area with an appropriate overlap and the process repeated.
   d. All areas where soap bubbles appear shall be marked, repaired and then retested.
   e. At locations where seams cannot be non destructively tested, such as pipe penetrations, alternate nondestructive spark testing (as outlined in section 3.4.B) or equivalent should be substituted.
   f. All seams that are vacuum tested shall be marked with the date tested, the name of the technician performing the test and the results of the test.

6. Double Fusion seams with an enclosed channel shall be air pressure tested by the Geomembrane Installer in accordance with ASTM D 5820 and ASTM D 4437 and the following equipment and procedures:
   a. Equipment for testing double fusion seams shall be comprised of but not limited to: an air pump equipped with a pressure gauge capable of generating and sustaining a pressure of 210 kPa (30 psig), mounted on a cushion to protect the geomembrane; and a manometer equipped with a sharp hollow needle or other approved pressure feed device.
   b. The Testing activities shall be performed by the Geomembrane Installer. Both ends of the seam to be tested shall be sealed and a needle or other approved pressure feed device inserted into the tunnel created by the double wedge fusion weld. The air pump shall be adjusted to a pressure of 210 kPa (30 psig), and the valve closed. Allow 2 minutes for the injected air to come to equilibrium in the channel, and sustain pressure for 5 minutes. If pressure loss does not exceed 28 kPa (4 psig) after this five minute period the seam shall be considered leak tight. Release pressure from the opposite end verifying pressure drop on needle to

ensure testing of the entire seam. The needle or other approved pressure feed device shall be removed and the feed hole sealed.

c. If loss of pressure exceeds 28 kPa (4 psig) during the testing period or pressure does not stabilize, the faulty area shall be located, repaired and retested by the Geomembrane Installer.

d. Results of the pressure testing shall be recorded on the liner at the seam tested and on a pressure testing record.

C. Leak Location Survey Testing

1. A leak location survey of the geomembrane liner shall be performed as specified in Section 02777 – Geomembrane Leak Location Survey.

D. Destructive Field Seam Testing

1. One destructive test sample per 150 linear m (500 linear ft) seam length or another predetermined length in accordance with GRI GM 14 shall be taken by the Geomembrane Installer from a location specified by the Engineer. The Geomembrane Installer shall not be informed in advance of the sample location. In order to obtain test results prior to completion of geomembrane installation, samples shall be cut by the Geomembrane Installer as directed by the Engineer as seaming progresses.

2. All field samples shall be marked with their sample number and seam number. The sample number, date, time, location, and seam number shall be recorded. The Geomembrane Installer shall repair all holes in the geomembrane resulting from obtaining the seam samples. All patches shall be vacuum box tested or spark tested. If a patch cannot be permanently installed over the test location the same day of sample collection, a temporary patch shall be tack welded or hot air welded over the opening until a permanent patch can be affixed.

3. The destructive sample size shall be 300 mm (12 in) wide by 1 m (36 in) long with the seam centered lengthwise. The sample shall be cut into three equal sections and distributed as follows: one section given to the Engineer as an archive sample; one section given to the Engineer for laboratory testing as specified in paragraph 5 below; and one section retained by the Geomembrane Installer for field testing as specified in paragraph 4 below.

4. For field testing, the Geomembrane Installer shall cut 10 identical 25 mm (1 in) wide replicate specimens from his sample. The Geomembrane Installer shall test five specimens for seam shear strength and five for peel strength. Peel tests will be performed on both inside and outside weld tracks. To be acceptable, 4 of 5 test specimens must pass the stated criteria in section 2.2 with less than 10% separation. If 4 of 5 specimens pass, the sample qualifies for testing by the testing laboratory if required.

5. If independent seam testing is required by the specifications it shall be conducted in accordance with ASTM 5820 or ASTM D4437 or GRI GM 6.

6. Reports of the results of examinations and testing shall be prepared and submitted to the Engineer.

7. For field seams, if a laboratory test fails, that shall be considered as an indicator of the possible inadequacy of the entire seamed length corresponding to the test sample. Additional destructive test portions shall then be taken by the Geomembrane Installer at locations indicated by the Engineer, typically 3 m (10 ft) on either side of the failed sample and laboratory seem tests shall be performed. Passing tests shall be an indicator of adequate seams. Failing tests shall be an indicator of non-adequate seams and all seams represented by the destructive test location shall be repaired with a cap-strip extrusion welded to all sides of the capped area. All cap-strip seams shall be non-destructively vacuum box tested until adequacy of the seams is achieved. Cap strip seams exceeding 50 m in length (150 ft) shall be destructively tested.

E. Identification of Defects

1. Panels and seams shall be inspected by the Installer and Engineer during and after panel deployment to identify all defects, including holes, blisters, undispersed raw materials and signs of contamination by foreign matter.

F. Evaluation of Defects

Each suspect location on the liner (both in geomembrane seam and non-seam areas) shall be non-destructively tested using one of the methods described in Section 3.5.B. Each location which fails non-destructive testing shall be marked, numbered, measured and posted on the daily "installation" drawings and subsequently repaired.

1. If a destructive sample fails the field or laboratory test, the Geomembrane Installer shall repair the seam between the two nearest passed locations on both sides of the failed destructive sample location.

2. Defective seams, tears or holes shall be repaired by reseaming or applying an extrusion welded cap strip.

3. Reseaming may consist of either:
   a. Removing the defective weld area and rewelding the parent material using the original welding equipment; or
   b. Reseaming by extrusion welding along the overlap at the outside seam edge left by the fusion welding process.

4. Blisters, larger holes, and contamination by foreign matter shall be repaired by patches and/or extrusion weld beads as required. Each patch shall extend a minimum of 150 mm (6 in) beyond all edges of the defects.

5. All repairs shall be measured, located and recorded.

G. Verification of Repairs on Seams

Each repair shall be non-destructively tested using either vacuum box or spark testing methods. Tests which pass the non-destructive test shall be taken as an indication of a successful repair. Failed tests shall be reseamed and retested until a passing test results. The number, date, location, technician and test outcome of each patch shall be recorded.

H. Daily Field Installation Reports

At the beginning of each day's work, the Installer shall provide the General Contractor with daily reports for all work accomplished on the previous work day by 9:00 am local time the following day. Reports shall include the following:

1. Total amount and location of geomembrane placed;
2. Total length and location of seams completed, name of technicians doing seaming and welding unit numbers;
3. Drawings of the previous day's installed geomembrane showing panel numbers, seam numbers and locations of non-destructive and destructive testing;
4. Results of pre-qualification test seams;
5. Results of non-destructive testing; and
6. Results of vacuum testing of repairs.

I. Destructive test results shall be reported prior to covering of liner or within 48 hours.

3.6 LINER ACCEPTANCE

A. Geomembrane liner will be accepted by the Engineer when:
   1. The entire installation is finished or an agreed upon subsection of the installation is finished;
   2. All Installer's QC documentation is completed and submitted to the Engineer within three (3) days of completing work.
   3. Verification of the adequacy of all field seams and repairs and associated geomembrane testing is complete.

3.7 ANCHOR TRENCH

A. Construct as specified on the project drawings.

3.8 DISPOSAL OF SCRAP MATERIALS

A. On completion of installation, the Geomembrane Installer shall dispose of all trash and scrap material in an EPA approved landfill, remove equipment used in connection with the work herein, and shall leave the premises in a neat acceptable manner. No scrap material shall be allowed to remain on the geomembrane surface.

PART 4: GRI GM13 SPECIFICATION

Attachment A: Minimum Average Weld Properties for HDPE Geomembranes

Minimum Average Weld Properties for Smooth and Textured HDPE Geomembranes (English units)								
Property	Test Method	30 mil	40 mil	50 mil	60 mil	80 mil	100 mil	120 mil

Peel strength (fusion & extrusion) lb/in.	ASTM 4437	39	52	65	78	104	130	156
Shear strength (fusion & extrusion) lb/in.	ASTM 4437	60	80	100	120	160	200	239

Attachment B: GRI GM13 Specification (11 pages attached)

END OF SECTION

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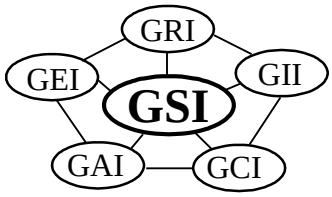

Revision 14: January 6, 2016
Revision schedule on pg. 11

GRI Test Method GM13*

Standard Specification for

"Test Methods, Test Properties and Testing Frequency for
High Density Polyethylene (HDPE) Smooth and Textured Geomembranes"

This specification was developed by the Geosynthetic Research Institute (GRI), with the cooperation of the member organizations for general use by the public. It is completely optional in this regard and can be superseded by other existing or new specifications on the subject matter in whole or in part. Neither GRI, the Geosynthetic Institute, nor any of its related institutes, warrant or indemnifies any materials produced according to this specification either at this time or in the future.

1. Scope

1.1 This specification covers high density polyethylene (HDPE) geomembranes with a formulated sheet density of 0.940 g/ml, or higher, in the thickness range of 0.75 mm (30 mils) to 3.0 mm (120 mils). Both smooth and textured geomembrane surfaces are included.

1.2 This specification sets forth a set of minimum, physical, mechanical and chemical properties that must be met, or exceeded by the geomembrane being manufactured. In a few cases a range is specified.

1.3 In the context of quality systems and management, this specification represents manufacturing quality control (MQC).

Note 1: Manufacturing quality control represents those actions taken by a manufacturer to ensure that the product represents the stated objective and properties set forth in this specification.

1.4 This standard specification is intended to ensure good quality and performance of HDPE geomembranes in general applications, but is possibly not adequate for the complete specification in a specific situation. Additional tests, or more restrictive

*This GRI standard is developed by the Geosynthetic Research Institute through consultation and review by the member organizations. This specification will be reviewed at least every 2-years, or on an as-required basis. In this regard it is subject to change at any time. The most recent revision date is the effective version.

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values for test indicated, may be necessary under conditions of a particular application.

Note 2: For information on installation techniques, users of this standard are referred to the geosynthetics literature, which is abundant on the subject.

2. Referenced Documents

2.1 ASTM Standards

D 792 Specific Gravity (Relative Density) and Density of Plastics by Displacement
D 1004 Test Method for Initial Tear Resistance of Plastics Film and Sheeting
D 1238 Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer
D 1505 Test Method for Density of Plastics by the Density-Gradient Technique
D 1603 Test Method for Carbon Black in Olefin Plastics
D 3895 Test Method for Oxidative Induction Time of Polyolefins by Thermal Analysis
D 4218 Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
D 4833 Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products
D 5199 Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes
D 5397 Procedure to Perform a Single Point Notched Constant Tensile Load – (SP-NCTL) Test: Appendix
D 5596 Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
D 5721 Practice for Air-Oven Aging of Polyolefin Geomembranes
D 5885 Test method for Oxidative Induction Time of Polyolefin Geosynthetics by High Pressure Differential Scanning Calorimetry
D 5994 Test Method for Measuring the Core Thickness of Textured Geomembranes
D 6370 Standard Test Method for Rubber-Compositional Analysis by Thermogravimetry (TGA)
D 6693 Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes
D 7238 Test Method for Effect of Exposure of Unreinforced Polyolefin Geomembrane Using Fluorescent UV Condensation Apparatus
D 7466 Test Method for Measuring the Asperity Height of Textured Geomembranes

2.2 GRI Standards

GM10 Specification for the Stress Crack Resistance of Geomembrane Sheet

2.3 U. S. Environmental Protection Agency Technical Guidance Document "Quality Control Assurance and Quality Control for Waste Containment Facilities," EPA/600/R-93/182, September 1993, 305 pgs.

3. Definitions

Manufacturing Quality Control (MQC) - A planned system of inspections that is used to directly monitor and control the manufacture of a material which is factory originated. MQC is normally performed by the manufacturer of geosynthetic materials and is necessary to ensure minimum (or maximum) specified values in the manufactured product. MQC refers to measures taken by the manufacturer to determine compliance with the requirements for materials and workmanship as stated in certification documents and contract specifications.
ref. EPA/600/R-93/182

Manufacturing Quality Assurance (MQA) - A planned system of activities that provides assurance that the materials were constructed as specified in the certification documents and contract specifications. MQA includes manufacturing facility inspections, verifications, audits and evaluation of the raw materials (resins and additives) and geosynthetic products to assess the quality of the manufactured materials. MQA refers to measures taken by the MQA organization to determine if the manufacturer is in compliance with the product certification and contract specifications for the project.
ref. EPA/600/R-93/182

Formulation, n - The mixture of a unique combination of ingredients identified by type, properties and quantity. For HDPE polyethylene geomembranes, a formulation is defined as the exact percentages and types of resin(s), additives and carbon black.

4. Material Classification and Formulation

4.1 This specification covers high density polyethylene geomembranes with a formulated sheet density of 0.940 g/ml, or higher. Density can be measured by ASTM D1505 or ASTM D792. If the latter, Method B is recommended.

4.2 The polyethylene resin from which the geomembrane is made will generally be in the density range of 0.932 g/ml or higher, and have a melt index value per ASTM D1238 of less than 1.0 g/10 min.

4.3 The resin shall be virgin material with no more than 10% rework. If rework is used, it must be a similar HDPE as the parent material.

4.4 No post consumer resin (PCR) of any type shall be added to the formulation.

5. Physical, Mechanical and Chemical Property Requirements

5.1 The geomembrane shall conform to the test property requirements prescribed in Tables 1 and 2. Table 1 is for smooth HDPE geomembranes and Table 2 is for single and double sided textured HDPE geomembranes. Each of the tables are given in English and SI (metric) units. The conversion from English to SI (metric) is soft.

Note 3: The tensile strength properties in this specification were originally based on ASTM D 638 which uses a laboratory testing temperature of 23°C ± 2°C. Since ASTM Committee D35 on Geosynthetics adopted ASTM D 6693 (in place of D 638), this GRI Specification followed accordingly. The difference is that D 6693 uses a testing temperature of 21°C ± 2°C. The numeric values of strength and elongation were not changed in this specification. If a dispute arises in this regard, the original temperature of 23°C ± 2°C should be utilized for testing purposes.

Note 4: There are several tests often included in other HDPE specifications which are omitted from this standard because they are outdated, irrelevant or generate information that is not necessary to evaluate on a routine MQC basis. The following tests have been purposely omitted:

- Volatile Loss
- Dimensional Stability
- Coeff. of Linear Expansion
- Resistance to Soil Burial
- Low Temperature Impact
- ESCR Test (D 1693)
- Wide Width Tensile
- Water Vapor Transmission
- Water Absorption
- Ozone Resistance
- Modulus of Elasticity
- Hydrostatic Resistance
- Tensile Impact
- Field Seam Strength
- Multi-Axial Burst
- Various Toxicity Tests

Note 5: There are several tests which are included in this standard (that are not customarily required in other HDPE specifications) because they are relevant and important in the context of current manufacturing processes. The following tests have been purposely added:

- Oxidative Induction Time
- Oven Aging
- Ultraviolet Resistance
- Asperity Height of Textured Sheet (see Note 6)

Note 6: The minimum average value of asperity height does not represent an expected value of interface shear strength. Shear strength associated with geomembranes is both site-specific and product-specific and should be determined by direct shear testing using ASTM D5321/ASTM D6243 as prescribed. This testing should be included in the particular site's CQA conformance testing protocol for the geosynthetic materials involved, or formally waived by the Design Engineer, with concurrence from the Owner prior to the deployment of the geosynthetic materials.

Note 7: There are other tests in this standard, focused on a particular property, which are updated to current standards. The following are in this category:

- Thickness of Textured Sheet
- Puncture Resistance
- Stress Crack Resistance
- Carbon Black Dispersion (In the viewing and subsequent quantitative interpretation of ASTM D 5596 only near spherical agglomerates shall be included in the assessment).

5.2 The values listed in the tables of this specification are to be interpreted according to the designated test method. In this respect they are neither minimum average roll values (MARV) nor maximum average roll values (MaxARV).

5.3 The properties of the HDPE geomembrane shall be tested at the minimum frequencies shown in Tables 1 and 2. If the specific manufacturer's quality control guide is more stringent and is certified accordingly, it must be followed in like manner.

Note 8: This specification is focused on manufacturing quality control (MQC). Conformance testing and manufacturing quality assurance (MQA) testing are at the discretion of the purchaser and/or quality assurance engineer, respectively.

6. Workmanship and Appearance

6.1 Smooth geomembrane shall have good appearance qualities. It shall be free from such defects that would affect the specified properties of the geomembrane.

6.2 Textured geomembrane shall generally have uniform texturing appearance. It shall be free from agglomerated texturing material and such defects that would affect the specified properties of the geomembrane.

6.3 General manufacturing procedures shall be performed in accordance with the manufacturer's internal quality control guide and/or documents.

7. MQC Sampling

7.1 Sampling shall be in accordance with the specific test methods listed in Tables 1 and 2. If no sampling protocol is stipulated in the particular test method, then test specimens shall be taken evenly spaced across the entire roll width.

7.2 The number of tests shall be in accordance with the appropriate test methods listed in Tables 1 and 2.

7.3 The average of the test results should be calculated per the particular standard cited and compared to the minimum value listed in these tables, hence the values listed are the minimum average values and are designated as "min. ave."

8. MQC Retest and Rejection

8.1 If the results of any test do not conform to the requirements of this specification, retesting to determine conformance or rejection should be done in accordance with the manufacturing protocol as set forth in the manufacturer's quality manual.

9. Packaging and Marketing

9.1 The geomembrane shall be rolled onto a substantial core or core segments and held firm by dedicated straps/slings, or other suitable means. The rolls must be adequate for safe transportation to the point of delivery, unless otherwise specified in the contract or order.

10. Certification

10.1 Upon request of the purchaser in the contract or order, a manufacturer's certification that the material was manufactured and tested in accordance with this specification, together with a report of the test results, shall be furnished at the time of shipment.

ENGLISH UNITS

Table 1(a) – High Density Polyethylene (HDPE) Geomembrane -Smooth

Properties	Test Method	Test Value							Testing Frequency (minimum)
		30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils	
Thickness (min. ave.)	D5199	nom.	nom.	nom.	nom.	nom.	nom.	nom.	Per roll
• lowest individual of 10 values		-10%	-10%	-10%	-10%	-10%	-10%	-10%	
Formulated Density mg/l (min.)	D 1505/D 792	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	200,000 lb
Tensile Properties *(1)* (min. ave.)	D 6693								20,000 lb
• yield strength	Type IV	63 lb/in.	84 lb/in.	105 lb/in.	126 lb/in.	168 lb/in.	210 lb/in.	252 lb/in.	
• break strength		114 lb/in.	152 lb/in.	190 lb/in.	228 lb/in.	304 lb/in.	380 lb/in.	456 lb/in.	
• yield elongation		12%	12%	12%	12%	12%	12%	12%	
• break elongation		700%	700%	700%	700%	700%	700%	700%	
Tear Resistance (min. ave.)	D 1004	21 lb	28 lb	35 lb	42 lb	56 lb	70 lb	84 lb	45,000 lb
Puncture Resistance (min. ave.)	D 4833	54 lb	72 lb	90 lb	108 lb	144 lb	180 lb	216 lb	45,000 lb
Stress Crack Resistance *(2)*	D5397 (App.)	500 hr.	500 hr.	500 hr.	500 hr.	500 hr.	500 hr.	500 hr.	per GRI-GM10
Carbon Black Content (range)	D 4218 *(3)*	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	20,000 lb
Carbon Black Dispersion	D 5596	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	45,000 lb
Oxidative Induction Time (OIT) (min. ave.) *(5)*									200,000 lb
(a) Standard OIT	D 3895	100 min.	100 min.	100 min.	100 min.	100 min.	100 min.	100 min.	
— or —									
(b) High Pressure OIT	D 5885	400 min.	400 min.	400 min.	400 min.	400 min.	400 min.	400 min.	
Oven Aging at 85°C *(5), (6)*	D 5721								
(a) Standard OIT (min. ave.) - % retained after 90 days	D 3895	55%	55%	55%	55%	55%	55%	55%	per each formulation
— or —									
(b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5885	80%	80%	80%	80%	80%	80%	80%	
UV Resistance *(7)*	D 7238								
(a) Standard OIT (min. ave.)	D 3895	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	per each formulation
— or —									
(b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(9)*	D 5885	50%	50%	50%	50%	50%	50%	50%	

(1) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
Yield elongation is calculated using a gage length of 1.3 inches
Break elongation is calculated using a gage length of 2.0 in.

(2) The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(3) Other methods such as D 1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.

(4) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in Categories 1 or 2 and 1 in Category 3

(5) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(6) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(7) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(8) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(9) UV resistance is based on percent retained value regardless of the original HP-OIT value.

SI (METRIC) UNITS

Table 1(b) – High Density Polyethylene (HPDE) Geomembrane - Smooth

Properties	Test Method	Test Value							Testing Frequency (minimum)
		0.75 mm	1.00 mm	1.25 mm	1.50 mm	2.00 mm	2.50 mm	3.00 mm	
Thickness - mils (min. ave.) • lowest individual of 10 values	D5199	nom. (mil) -10%	nom. (mil) -10%	nom. (mil) -10%	nom. (mil) -10%	nom. (mil) -10%	nom. (mil) -10%	nom. (mil) -10%	per roll
Formulated Density (min.)	D 1505/D 792	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	90,000 kg
Tensile Properties *(1)* (min. ave.) • yield strength • break strength • yield elongation • break elongation	D 6693 Type IV	 11 kN/m 20 kN/m 12% 700%	 15 kN/m 27 kN/m 12% 700%	 18 kN/m 33 kN/m 12% 700%	 22 kN/m 40 kN/m 12% 700%	 29 kN/m 53 kN/m 12% 700%	 37 kN/m 67 kN/m 12% 700%	 44 kN/m 80 kN/m 12% 700%	9,000 kg
Tear Resistance (min. ave.)	D 1004	93 N	125 N	156 N	187 N	249 N	311 N	374 N	20,000 kg
Puncture Resistance (min. ave.)	D 4833	240 N	320 N	400 N	480 N	640 N	800 N	960 N	20,000 kg
Stress Crack Resistance *(2)*	D 5397 (App.)	500 hr.	500 hr.	500 hr.	500 hr.	500 hr.	500 hr.	500 hr.	per GRI GM-10
Carbon Black Content - %	D 4218 *(3)*	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	9,000 kg
Carbon Black Dispersion	D 5596	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	20,000 kg
Oxidative Induction Time (OIT) (min. ave.) *(5)* (a) Standard OIT — or — (b) High Pressure OIT	 D 3895 D 5885	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	90,000 kg
Oven Aging at 85°C *(5), (6)* (a) Standard OIT (min. ave.) - % retained after 90 days — or — (b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5721 D 3895 D 5885	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	per each formulation
UV Resistance *(7)* (a) Standard OIT (min. ave.) — or — (b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(9)*	D 7238 D 3895 D 5885	 N. R. *(8)* 50%	 N.R. *(8)* 50%	 N.R. *(8)* 50%	 N.R. *(8)* 50%	 N.R. *(8)* 50%	 N.R. *(8)* 50%	 N.R. *(8)* 50%	per each formulation

(1) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction
Yield elongation is calculated using a gage length of 33 mm
Break elongation is calculated using a gage length of 50 mm

(2) The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(3) Other methods such as D 1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.

(4) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in Categories 1 or 2 and 1 in Category 3

(5) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(6) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(7) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(8) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(9) UV resistance is based on percent retained value regardless of the original HP-OIT value.

ENGLISH UNITS

Table 2(a) – High Density Polyethylene (HDPE) Geomembrane - Textured

Properties	Test Method	Test Value							Testing Frequency (minimum)
		30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils	
Thickness mils (min. ave.) • lowest individual for 8 out of 10 values • lowest individual for any of the 10 values	D 5994	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	per roll
Asperity Height mils (min. ave.)	D 7466	16 mil	16 mil	16 mil	16 mil	16 mil	16 mil	16 mil	every 2nd roll *(1)*
Formulated Density (min. ave.)	D 1505/D 792	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	200,000 lb
Tensile Properties (min. ave.) *(2)* • yield strength • break strength • yield elongation • break elongation	D 6693 Type IV	 63 lb/in. 45 lb/in. 12% 100%	 84 lb/in. 60 lb/in. 12% 100%	 105 lb/in. 75 lb/in. 12% 100%	 126 lb/in. 90 lb/in. 12% 100%	 168 lb/in. 120 lb/in. 12% 100%	 210 lb/in. 150 lb/in. 12% 100%	 252 lb/in. 180 lb/in. 12% 100%	20,000 lb
Tear Resistance (min. ave.)	D 1004	21 lb	28 lb	35 lb	42 lb	56 lb	70 lb	84 lb	45,000 lb
Puncture Resistance (min. ave.)	D 4833	45 lb	60 lb	75 lb	90 lb	120 lb	150 lb	180 lb	45,000 lb
Stress Crack Resistance *(3)*	D 5397 (App.)	500 hr.	500 hr.	500 hr.	500 hr.	500 hr.	500 hr.	500 hr.	per GRI GM10
Carbon Black Content (range)	D 4218 *(4)*	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	20,000 lb
Carbon Black Dispersion	D 5596	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	45,000 lb
Oxidative Induction Time (OIT) (min. ave.) *(6)* (a) Standard OIT — or — (b) High Pressure OIT	 D 3895 D 5885	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	200,000 lb
Oven Aging at 85°C *(6), (7)* (a) Standard OIT (min. ave.) - % retained after 90 days — or — (b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5721 D 3895 D 5885	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	per each formulation
UV Resistance *(8)* (a) Standard OIT (min. ave.) — or — (b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(10)*	D 7238 D 3895 D 5885	 N.R. *(9)* 50%	 N.R. *(9)* 50%	 N.R. *(9)* 50%	 N.R. *(9)* 50%	 N.R. *(9)* 50%	 N.R. *(9)* 50%	 N.R. *(9)* 50%	per each formulation

(1) Alternate the measurement side for double sided textured sheet

(2) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
Yield elongation is calculated using a gage length of 1.3 inches
Break elongation is calculated using a gage length of 2.0 inches

(3) P-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials.
The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(4) Other methods such as D 1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.

(5) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in Categories 1 or 2 and 1 in Category 3

(6) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(7) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(8) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(9) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(10) UV resistance is based on percent retained value regardless of the original HP-OIT value.

SI (METRIC UNITS)

Table 2(b) – High Density Polyethylene (HDPE) Geomembrane - Textured

Properties	Test Method	Test Value							Testing Frequency (minimum)
		0.75 mm	1.00 mm	1.25 mm	1.50 mm	2.00 mm	2.50 mm	3.00 mm	
Thickness mils (min. ave.) • lowest individual for 8 out of 10 values • lowest individual for any of the 10 values	D 5994	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	per roll
Asperity Height mils (min. ave.)	D 7466	0.40 mm	0.40 mm	0.40 mm	0.40 mm	0.40 mm	0.40 mm	0.40 mm	every 2nd roll *(1)*
Formulated Density (min. ave.)	D 1505/D 792	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	90,000 kg
Tensile Properties (min. ave.) *(2)* • yield strength • break strength • yield elongation • break elongation	D 6693 Type IV	 11 kN/m 8 kN/m 12% 100%	 15 kN/m 10 kN/m 12% 100%	 18 kN/m 13 kN/m 12% 100%	 22 kN/m 16 kN/m 12% 100%	 29 kN/m 21 kN/m 12% 100%	 37 kN/m 26 kN/m 12% 100%	 44 kN/m 32 kN/m 12% 100%	9,000 kg
Tear Resistance (min. ave.)	D 1004	93 N	125 N	156 N	187 N	249 N	311 N	374 N	20,000 kg
Puncture Resistance (min. ave.)	D 4833	200N	267 N	333 N	400 N	534 N	667 N	800 N	20,000 kg
Stress Crack Resistance *(3)*	D 5397 (App.)	500 hr.	500 hr.	500 hr.	500 hr.	500 hr.	500 hr.	500 hr.	per GRI GM10
Carbon Black Content (range)	D 4218 *(4)*	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	9,000 kg
Carbon Black Dispersion	D 5596	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	20,000 kg
Oxidative Induction Time (OIT) (min. ave.) *(6)* (a) Standard OIT — or — (b) High Pressure OIT	 D 3895 D 5885	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	90,000 kg
Oven Aging at 85°C *(6), (7)* (a) Standard OIT (min. ave.) - % retained after 90 days — or — (b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5721 D 3895 D 5885	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	per each formulation
UV Resistance *(8)* (a) Standard OIT (min. ave.) — or — (b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(10)*	D 7238 D 3895 D 5885	 N.R. *(9)* 50%	 N.R. *(9)* 50%	 N.R. *(9)* 50%	 N.R. *(9)* 50%	 N.R. *(9)* 50%	 N.R. *(9)* 50%	 N.R. *(9)* 50%	per each formulation

(1) Alternate the measurement side for double sided textured sheet

(2) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
Yield elongation is calculated using a gage length of 33 mm
Break elongation is calculated using a gage length of 50 mm

(3) The SP-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials.
The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(4) Other methods such as D 1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.

(5) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in Categories 1 or 2 and 1 in Category 3

(6) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(7) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(8) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(9) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(10) UV resistance is based on percent retained value regardless of the original HP-OIT value.

Adoption and Revision Schedule
for
HDPE Specification per GRI-GM13

"Test Methods, Test Properties, Testing Frequency for
High Density Polyethylene (HDPE) Smooth and Textured Geomembranes"

Adopted:	June 17, 1997
Revision 1:	November 20, 1998; changed CB dispersion from allowing 2 views to be in Category 3 to requiring all 10 views to be in Category 1 or 2. Also reduced UV percent retained from 60% to 50%.
Revision 2:	April 29, 1999: added to Note 5 after the listing of Carbon Black Dispersion the following: "(In the viewing and subsequent quantitative interpretation of ASTM D5596 only near spherical agglomerates shall be included in the assessment)" and to Note (4) in the property tables.
Revision 3:	June 28, 2000: added a new Section 5.2 that the numeric table values are neither MARV or MaxARV. They are to be interpreted per the the designated test method.
Revision 4:	December 13, 2000: added one Category 3 is allowed for carbon black dispersion. Also, unified terminology to "strength" and "elongation".
Revision 5:	May 15, 2003: Increased minimum acceptable stress crack resistance time from 200 hrs to 300 hrs.
Revision 6:	June 23, 2003: Adopted ASTM D 6693, in place of ASTM D 638, for tensile strength testing. Also, added Note 2.
Revision 7:	February 20, 2006: Added Note 6 on Asperity Height clarification with respect to shear strength.
Revision 8:	Removed recommended warranty from specification.
Revision 9:	June 1, 2009: Replaced GRI-GM12 test for asperity height of textured geomembranes with ASTM D 7466.
Revision 10	April 11, 2011: Added alternative carbon black content test methods
Revision 11	December 13, 2012: Replaced GRI-GM11 with the equivalent ASTM D 7238.
Revision 12	November 14, 2014: Increased minimum acceptable stress crack resistance time from 300 to 500 hours. Also, increased asperity height of textured sheet from 10 to 16 mils (0.25 to 0.40 mm).
Revision 13	November 4, 2015: Removed Footnote (1) on asperity height from tables.
Revision 14	January 6, 2016: Removed Trouser Tear from Note 5.

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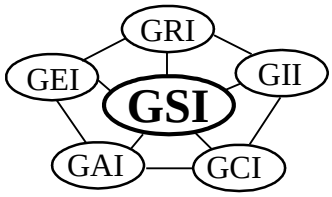

Revision 14: January 6, 2016
Revision schedule on pg. 11

GRI Test Method GM13*

Standard Specification for

"Test Methods, Test Properties and Testing Frequency for
High Density Polyethylene (HDPE) Smooth and Textured Geomembranes"

This specification was developed by the Geosynthetic Research Institute (GRI), with the cooperation of the member organizations for general use by the public. It is completely optional in this regard and can be superseded by other existing or new specifications on the subject matter in whole or in part. Neither GRI, the Geosynthetic Institute, nor any of its related institutes, warrant or indemnifies any materials produced according to this specification either at this time or in the future.

1. Scope

1.1 This specification covers high density polyethylene (HDPE) geomembranes with a formulated sheet density of 0.940 g/ml, or higher, in the thickness range of 0.75 mm (30 mils) to 3.0 mm (120 mils). Both smooth and textured geomembrane surfaces are included.

1.2 This specification sets forth a set of minimum, physical, mechanical and chemical properties that must be met, or exceeded by the geomembrane being manufactured. In a few cases a range is specified.

1.3 In the context of quality systems and management, this specification represents manufacturing quality control (MQC).

Note 1: Manufacturing quality control represents those actions taken by a manufacturer to ensure that the product represents the stated objective and properties set forth in this specification.

1.4 This standard specification is intended to ensure good quality and performance of HDPE geomembranes in general applications, but is possibly not adequate for the complete specification in a specific situation. Additional tests, or more restrictive

*This GRI standard is developed by the Geosynthetic Research Institute through consultation and review by the member organizations. This specification will be reviewed at least every 2-years, or on an as-required basis. In this regard it is subject to change at any time. The most recent revision date is the effective version.

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values for test indicated, may be necessary under conditions of a particular application.

Note 2: For information on installation techniques, users of this standard are referred to the geosynthetics literature, which is abundant on the subject.

2. Referenced Documents

2.1 ASTM Standards

D 792 Specific Gravity (Relative Density) and Density of Plastics by Displacement
D 1004 Test Method for Initial Tear Resistance of Plastics Film and Sheeting
D 1238 Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer
D 1505 Test Method for Density of Plastics by the Density-Gradient Technique
D 1603 Test Method for Carbon Black in Olefin Plastics
D 3895 Test Method for Oxidative Induction Time of Polyolefins by Thermal Analysis
D 4218 Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
D 4833 Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products
D 5199 Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes
D 5397 Procedure to Perform a Single Point Notched Constant Tensile Load – (SP-NCTL) Test: Appendix
D 5596 Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
D 5721 Practice for Air-Oven Aging of Polyolefin Geomembranes
D 5885 Test method for Oxidative Induction Time of Polyolefin Geosynthetics by High Pressure Differential Scanning Calorimetry
D 5994 Test Method for Measuring the Core Thickness of Textured Geomembranes
D 6370 Standard Test Method for Rubber-Compositional Analysis by Thermogravimetry (TGA)
D 6693 Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes
D 7238 Test Method for Effect of Exposure of Unreinforced Polyolefin Geomembrane Using Fluorescent UV Condensation Apparatus
D 7466 Test Method for Measuring the Asperity Height of Textured Geomembranes

2.2 GRI Standards

GM10 Specification for the Stress Crack Resistance of Geomembrane Sheet

2.3 U. S. Environmental Protection Agency Technical Guidance Document "Quality Control Assurance and Quality Control for Waste Containment Facilities," EPA/600/R-93/182, September 1993, 305 pgs.

3. Definitions

Manufacturing Quality Control (MQC) - A planned system of inspections that is used to directly monitor and control the manufacture of a material which is factory originated. MQC is normally performed by the manufacturer of geosynthetic materials and is necessary to ensure minimum (or maximum) specified values in the manufactured product. MQC refers to measures taken by the manufacturer to determine compliance with the requirements for materials and workmanship as stated in certification documents and contract specifications.
ref. EPA/600/R-93/182

Manufacturing Quality Assurance (MQA) - A planned system of activities that provides assurance that the materials were constructed as specified in the certification documents and contract specifications. MQA includes manufacturing facility inspections, verifications, audits and evaluation of the raw materials (resins and additives) and geosynthetic products to assess the quality of the manufactured materials. MQA refers to measures taken by the MQA organization to determine if the manufacturer is in compliance with the product certification and contract specifications for the project.
ref. EPA/600/R-93/182

Formulation, n - The mixture of a unique combination of ingredients identified by type, properties and quantity. For HDPE polyethylene geomembranes, a formulation is defined as the exact percentages and types of resin(s), additives and carbon black.

4. Material Classification and Formulation

4.1 This specification covers high density polyethylene geomembranes with a formulated sheet density of 0.940 g/ml, or higher. Density can be measured by ASTM D1505 or ASTM D792. If the latter, Method B is recommended.

4.2 The polyethylene resin from which the geomembrane is made will generally be in the density range of 0.932 g/ml or higher, and have a melt index value per ASTM D1238 of less than 1.0 g/10 min.

4.3 The resin shall be virgin material with no more than 10% rework. If rework is used, it must be a similar HDPE as the parent material.

4.4 No post consumer resin (PCR) of any type shall be added to the formulation.

5. Physical, Mechanical and Chemical Property Requirements

5.1 The geomembrane shall conform to the test property requirements prescribed in Tables 1 and 2. Table 1 is for smooth HDPE geomembranes and Table 2 is for single and double sided textured HDPE geomembranes. Each of the tables are given in English and SI (metric) units. The conversion from English to SI (metric) is soft.

Note 3: The tensile strength properties in this specification were originally based on ASTM D 638 which uses a laboratory testing temperature of 23°C ± 2°C. Since ASTM Committee D35 on Geosynthetics adopted ASTM D 6693 (in place of D 638), this GRI Specification followed accordingly. The difference is that D 6693 uses a testing temperature of 21°C ± 2°C. The numeric values of strength and elongation were not changed in this specification. If a dispute arises in this regard, the original temperature of 23°C ± 2°C should be utilized for testing purposes.

Note 4: There are several tests often included in other HDPE specifications which are omitted from this standard because they are outdated, irrelevant or generate information that is not necessary to evaluate on a routine MQC basis. The following tests have been purposely omitted:

- Volatile Loss
- Dimensional Stability
- Coeff. of Linear Expansion
- Resistance to Soil Burial
- Low Temperature Impact
- ESCR Test (D 1693)
- Wide Width Tensile
- Water Vapor Transmission
- Water Absorption
- Ozone Resistance
- Modulus of Elasticity
- Hydrostatic Resistance
- Tensile Impact
- Field Seam Strength
- Multi-Axial Burst
- Various Toxicity Tests

Note 5: There are several tests which are included in this standard (that are not customarily required in other HDPE specifications) because they are relevant and important in the context of current manufacturing processes. The following tests have been purposely added:

- Oxidative Induction Time
- Oven Aging
- Ultraviolet Resistance
- Asperity Height of Textured Sheet (see Note 6)

Note 6: The minimum average value of asperity height does not represent an expected value of interface shear strength. Shear strength associated with geomembranes is both site-specific and product-specific and should be determined by direct shear testing using ASTM D5321/ASTM D6243 as prescribed. This testing should be included in the particular site's CQA conformance testing protocol for the geosynthetic materials involved, or formally waived by the Design Engineer, with concurrence from the Owner prior to the deployment of the geosynthetic materials.

Note 7: There are other tests in this standard, focused on a particular property, which are updated to current standards. The following are in this category:

- Thickness of Textured Sheet
- Puncture Resistance
- Stress Crack Resistance
- Carbon Black Dispersion (In the viewing and subsequent quantitative interpretation of ASTM D 5596 only near spherical agglomerates shall be included in the assessment).

5.2 The values listed in the tables of this specification are to be interpreted according to the designated test method. In this respect they are neither minimum average roll values (MARV) nor maximum average roll values (MaxARV).

5.3 The properties of the HDPE geomembrane shall be tested at the minimum frequencies shown in Tables 1 and 2. If the specific manufacturer's quality control guide is more stringent and is certified accordingly, it must be followed in like manner.

Note 8: This specification is focused on manufacturing quality control (MQC). Conformance testing and manufacturing quality assurance (MQA) testing are at the discretion of the purchaser and/or quality assurance engineer, respectively.

6. Workmanship and Appearance

6.1 Smooth geomembrane shall have good appearance qualities. It shall be free from such defects that would affect the specified properties of the geomembrane.

6.2 Textured geomembrane shall generally have uniform texturing appearance. It shall be free from agglomerated texturing material and such defects that would affect the specified properties of the geomembrane.

6.3 General manufacturing procedures shall be performed in accordance with the manufacturer's internal quality control guide and/or documents.

7. MQC Sampling

7.1 Sampling shall be in accordance with the specific test methods listed in Tables 1 and 2. If no sampling protocol is stipulated in the particular test method, then test specimens shall be taken evenly spaced across the entire roll width.

7.2 The number of tests shall be in accordance with the appropriate test methods listed in Tables 1 and 2.

7.3 The average of the test results should be calculated per the particular standard cited and compared to the minimum value listed in these tables, hence the values listed are the minimum average values and are designated as "min. ave."

8. MQC Retest and Rejection

8.1 If the results of any test do not conform to the requirements of this specification, retesting to determine conformance or rejection should be done in accordance with the manufacturing protocol as set forth in the manufacturer's quality manual.

9. Packaging and Marketing

9.1 The geomembrane shall be rolled onto a substantial core or core segments and held firm by dedicated straps/slings, or other suitable means. The rolls must be adequate for safe transportation to the point of delivery, unless otherwise specified in the contract or order.

10. Certification

10.1 Upon request of the purchaser in the contract or order, a manufacturer's certification that the material was manufactured and tested in accordance with this specification, together with a report of the test results, shall be furnished at the time of shipment.

ENGLISH UNITS

Table 1(a) – High Density Polyethylene (HDPE) Geomembrane -Smooth

Properties	Test Method	Test Value							Testing Frequency (minimum)
		30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils	
Thickness (min. ave.)	D5199	nom.	nom.	nom.	nom.	nom.	nom.	nom.	Per roll
• lowest individual of 10 values		-10%	-10%	-10%	-10%	-10%	-10%	-10%	
Formulated Density mg/l (min.)	D 1505/D 792	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	200,000 lb
Tensile Properties *(1)* (min. ave.)	D 6693								20,000 lb
• yield strength	Type IV	63 lb/in.	84 lb/in.	105 lb/in.	126 lb/in.	168 lb/in.	210 lb/in.	252 lb/in.	
• break strength		114 lb/in.	152 lb/in.	190 lb/in.	228 lb/in.	304 lb/in.	380 lb/in.	456 lb/in.	
• yield elongation		12%	12%	12%	12%	12%	12%	12%	
• break elongation		700%	700%	700%	700%	700%	700%	700%	
Tear Resistance (min. ave.)	D 1004	21 lb	28 lb	35 lb	42 lb	56 lb	70 lb	84 lb	45,000 lb
Puncture Resistance (min. ave.)	D 4833	54 lb	72 lb	90 lb	108 lb	144 lb	180 lb	216 lb	45,000 lb
Stress Crack Resistance *(2)*	D5397 (App.)	500 hr.	500 hr.	500 hr.	500 hr.	500 hr.	500 hr.	500 hr.	per GRI-GM10
Carbon Black Content (range)	D 4218 *(3)*	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	20,000 lb
Carbon Black Dispersion	D 5596	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	45,000 lb
Oxidative Induction Time (OIT) (min. ave.) *(5)*									200,000 lb
(a) Standard OIT	D 3895	100 min.	100 min.	100 min.	100 min.	100 min.	100 min.	100 min.	
— or —									
(b) High Pressure OIT	D 5885	400 min.	400 min.	400 min.	400 min.	400 min.	400 min.	400 min.	
Oven Aging at 85°C *(5), (6)*	D 5721								
(a) Standard OIT (min. ave.) - % retained after 90 days	D 3895	55%	55%	55%	55%	55%	55%	55%	per each formulation
— or —									
(b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5885	80%	80%	80%	80%	80%	80%	80%	
UV Resistance *(7)*	D 7238								
(a) Standard OIT (min. ave.)	D 3895	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	per each formulation
— or —									
(b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(9)*	D 5885	50%	50%	50%	50%	50%	50%	50%	

(1) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
Yield elongation is calculated using a gage length of 1.3 inches
Break elongation is calculated using a gage length of 2.0 in.

(2) The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(3) Other methods such as D 1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.

(4) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in Categories 1 or 2 and 1 in Category 3

(5) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(6) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(7) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(8) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(9) UV resistance is based on percent retained value regardless of the original HP-OIT value.

SI (METRIC) UNITS

Table 1(b) – High Density Polyethylene (HPDE) Geomembrane - Smooth

Properties	Test Method	Test Value							Testing Frequency (minimum)
		0.75 mm	1.00 mm	1.25 mm	1.50 mm	2.00 mm	2.50 mm	3.00 mm	
Thickness - mils (min. ave.) • lowest individual of 10 values	D5199	nom. (mil) -10%	nom. (mil) -10%	nom. (mil) -10%	nom. (mil) -10%	nom. (mil) -10%	nom. (mil) -10%	nom. (mil) -10%	per roll
Formulated Density (min.)	D 1505/D 792	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	90,000 kg
Tensile Properties *(1)* (min. ave.) • yield strength • break strength • yield elongation • break elongation	D 6693 Type IV	 11 kN/m 20 kN/m 12% 700%	 15 kN/m 27 kN/m 12% 700%	 18 kN/m 33 kN/m 12% 700%	 22 kN/m 40 kN/m 12% 700%	 29 kN/m 53 kN/m 12% 700%	 37 kN/m 67 kN/m 12% 700%	 44 kN/m 80 kN/m 12% 700%	9,000 kg
Tear Resistance (min. ave.)	D 1004	93 N	125 N	156 N	187 N	249 N	311 N	374 N	20,000 kg
Puncture Resistance (min. ave.)	D 4833	240 N	320 N	400 N	480 N	640 N	800 N	960 N	20,000 kg
Stress Crack Resistance *(2)*	D 5397 (App.)	500 hr.	500 hr.	500 hr.	500 hr.	500 hr.	500 hr.	500 hr.	per GRI GM-10
Carbon Black Content - %	D 4218 *(3)*	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	9,000 kg
Carbon Black Dispersion	D 5596	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	20,000 kg
Oxidative Induction Time (OIT) (min. ave.) *(5)* (a) Standard OIT — or — (b) High Pressure OIT	 D 3895 D 5885	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	90,000 kg
Oven Aging at 85°C *(5), (6)* (a) Standard OIT (min. ave.) - % retained after 90 days — or — (b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5721 D 3895 D 5885	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	per each formulation
UV Resistance *(7)* (a) Standard OIT (min. ave.) — or — (b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(9)*	D 7238 D 3895 D 5885	 N. R. *(8)* 50%	 N.R. *(8)* 50%	 N.R. *(8)* 50%	 N.R. *(8)* 50%	 N.R. *(8)* 50%	 N.R. *(8)* 50%	 N.R. *(8)* 50%	per each formulation

(1) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction
Yield elongation is calculated using a gage length of 33 mm
Break elongation is calculated using a gage length of 50 mm

(2) The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(3) Other methods such as D 1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.

(4) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in Categories 1 or 2 and 1 in Category 3

(5) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(6) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(7) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(8) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(9) UV resistance is based on percent retained value regardless of the original HP-OIT value.

ENGLISH UNITS

Table 2(a) – High Density Polyethylene (HDPE) Geomembrane - Textured

Properties	Test Method	Test Value							Testing Frequency (minimum)
		30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils	
Thickness mils (min. ave.) • lowest individual for 8 out of 10 values • lowest individual for any of the 10 values	D 5994	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	per roll
Asperity Height mils (min. ave.)	D 7466	16 mil	16 mil	16 mil	16 mil	16 mil	16 mil	16 mil	every 2nd roll *(1)*
Formulated Density (min. ave.)	D 1505/D 792	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	200,000 lb
Tensile Properties (min. ave.) *(2)* • yield strength • break strength • yield elongation • break elongation	D 6693 Type IV	 63 lb/in. 45 lb/in. 12% 100%	 84 lb/in. 60 lb/in. 12% 100%	 105 lb/in. 75 lb/in. 12% 100%	 126 lb/in. 90 lb/in. 12% 100%	 168 lb/in. 120 lb/in. 12% 100%	 210 lb/in. 150 lb/in. 12% 100%	 252 lb/in. 180 lb/in. 12% 100%	20,000 lb
Tear Resistance (min. ave.)	D 1004	21 lb	28 lb	35 lb	42 lb	56 lb	70 lb	84 lb	45,000 lb
Puncture Resistance (min. ave.)	D 4833	45 lb	60 lb	75 lb	90 lb	120 lb	150 lb	180 lb	45,000 lb
Stress Crack Resistance *(3)*	D 5397 (App.)	500 hr.	500 hr.	500 hr.	500 hr.	500 hr.	500 hr.	500 hr.	per GRI GM10
Carbon Black Content (range)	D 4218 *(4)*	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	20,000 lb
Carbon Black Dispersion	D 5596	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	45,000 lb
Oxidative Induction Time (OIT) (min. ave.) *(6)* (a) Standard OIT — or — (b) High Pressure OIT	 D 3895 D 5885	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	200,000 lb
Oven Aging at 85°C *(6), (7)* (a) Standard OIT (min. ave.) - % retained after 90 days — or — (b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5721 D 3895 D 5885	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	per each formulation
UV Resistance *(8)* (a) Standard OIT (min. ave.) — or — (b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(10)*	D 7238 D 3895 D 5885	 N.R. *(9)* 50%	 N.R. *(9)* 50%	 N.R. *(9)* 50%	 N.R. *(9)* 50%	 N.R. *(9)* 50%	 N.R. *(9)* 50%	 N.R. *(9)* 50%	per each formulation

(1) Alternate the measurement side for double sided textured sheet

(2) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
Yield elongation is calculated using a gage length of 1.3 inches
Break elongation is calculated using a gage length of 2.0 inches

(3) P-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials.
The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(4) Other methods such as D 1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.

(5) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in Categories 1 or 2 and 1 in Category 3

(6) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(7) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(8) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(9) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(10) UV resistance is based on percent retained value regardless of the original HP-OIT value.

SI (METRIC UNITS)

Table 2(b) – High Density Polyethylene (HDPE) Geomembrane - Textured

Properties	Test Method	Test Value							Testing Frequency (minimum)
		0.75 mm	1.00 mm	1.25 mm	1.50 mm	2.00 mm	2.50 mm	3.00 mm	
Thickness mils (min. ave.) • lowest individual for 8 out of 10 values • lowest individual for any of the 10 values	D 5994	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	per roll
Asperity Height mils (min. ave.)	D 7466	0.40 mm	0.40 mm	0.40 mm	0.40 mm	0.40 mm	0.40 mm	0.40 mm	every 2nd roll *(1)*
Formulated Density (min. ave.)	D 1505/D 792	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	90,000 kg
Tensile Properties (min. ave.) *(2)* • yield strength • break strength • yield elongation • break elongation	D 6693 Type IV	 11 kN/m 8 kN/m 12% 100%	 15 kN/m 10 kN/m 12% 100%	 18 kN/m 13 kN/m 12% 100%	 22 kN/m 16 kN/m 12% 100%	 29 kN/m 21 kN/m 12% 100%	 37 kN/m 26 kN/m 12% 100%	 44 kN/m 32 kN/m 12% 100%	9,000 kg
Tear Resistance (min. ave.)	D 1004	93 N	125 N	156 N	187 N	249 N	311 N	374 N	20,000 kg
Puncture Resistance (min. ave.)	D 4833	200N	267 N	333 N	400 N	534 N	667 N	800 N	20,000 kg
Stress Crack Resistance *(3)*	D 5397 (App.)	500 hr.	500 hr.	500 hr.	500 hr.	500 hr.	500 hr.	500 hr.	per GRI GM10
Carbon Black Content (range)	D 4218 *(4)*	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	9,000 kg
Carbon Black Dispersion	D 5596	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	20,000 kg
Oxidative Induction Time (OIT) (min. ave.) *(6)* (a) Standard OIT — or — (b) High Pressure OIT	 D 3895 D 5885	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	90,000 kg
Oven Aging at 85°C *(6), (7)* (a) Standard OIT (min. ave.) - % retained after 90 days — or — (b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5721 D 3895 D 5885	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	per each formulation
UV Resistance *(8)* (a) Standard OIT (min. ave.) — or — (b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(10)*	D 7238 D 3895 D 5885	 N.R. *(9)* 50%	 N.R. *(9)* 50%	 N.R. *(9)* 50%	 N.R. *(9)* 50%	 N.R. *(9)* 50%	 N.R. *(9)* 50%	 N.R. *(9)* 50%	per each formulation

(1) Alternate the measurement side for double sided textured sheet

(2) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
Yield elongation is calculated using a gage length of 33 mm
Break elongation is calculated using a gage length of 50 mm

(3) The SP-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials.
The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(4) Other methods such as D 1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.

(5) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in Categories 1 or 2 and 1 in Category 3

(6) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(7) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(8) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(9) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(10) UV resistance is based on percent retained value regardless of the original HP-OIT value.

Adoption and Revision Schedule
for
HDPE Specification per GRI-GM13

"Test Methods, Test Properties, Testing Frequency for
High Density Polyethylene (HDPE) Smooth and Textured Geomembranes"

Adopted:	June 17, 1997
Revision 1:	November 20, 1998; changed CB dispersion from allowing 2 views to be in Category 3 to requiring all 10 views to be in Category 1 or 2. Also reduced UV percent retained from 60% to 50%.
Revision 2:	April 29, 1999: added to Note 5 after the listing of Carbon Black Dispersion the following: "(In the viewing and subsequent quantitative interpretation of ASTM D5596 only near spherical agglomerates shall be included in the assessment)" and to Note (4) in the property tables.
Revision 3:	June 28, 2000: added a new Section 5.2 that the numeric table values are neither MARV or MaxARV. They are to be interpreted per the the designated test method.
Revision 4:	December 13, 2000: added one Category 3 is allowed for carbon black dispersion. Also, unified terminology to "strength" and "elongation".
Revision 5:	May 15, 2003: Increased minimum acceptable stress crack resistance time from 200 hrs to 300 hrs.
Revision 6:	June 23, 2003: Adopted ASTM D 6693, in place of ASTM D 638, for tensile strength testing. Also, added Note 2.
Revision 7:	February 20, 2006: Added Note 6 on Asperity Height clarification with respect to shear strength.
Revision 8:	Removed recommended warranty from specification.
Revision 9:	June 1, 2009: Replaced GRI-GM12 test for asperity height of textured geomembranes with ASTM D 7466.
Revision 10	April 11, 2011: Added alternative carbon black content test methods
Revision 11	December 13, 2012: Replaced GRI-GM11 with the equivalent ASTM D 7238.
Revision 12	November 14, 2014: Increased minimum acceptable stress crack resistance time from 300 to 500 hours. Also, increased asperity height of textured sheet from 10 to 16 mils (0.25 to 0.40 mm).
Revision 13	November 4, 2015: Removed Footnote (1) on asperity height from tables.
Revision 14	January 6, 2016: Removed Trouser Tear from Note 5.

TETRA TECH	**Non-Woven Geotextile** **Technical Specification**	**SPECIFICATION NUMBER: 02373** **PROJECT NUMBER: 117-7502016-L09** **PROJECT NAME: Weir Dewatering Treatment**

SPECIFICATION REVISION INDEX

Revision No.	Revision Date	Issued for	Signatures				
			Prepared By	Reviewed By	Project Engineer	Project Manager	Client
A	2/15/2017	75% Submittal	CAH	HL	JG	STD	

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SECTION 02373

NON-WOVEN GEOTEXTILE

PART 1 - GENERAL

1.01 SUMMARY

The Geotextile Sub-Contractor shall furnish all labor, materials, and equipment necessary for the installation of the non-woven geotextile in accordance with the Drawings and Specifications.

1.02 SYSTEM DESCRIPTION

The non-woven geotextile is intended to act as a separation geotextile between the geomembrane and stone.

1.03 SUBMITTALS

The Geotextile Sub-Contractor shall furnish the following information to the Engineer in accordance with the Specifications.

A. Geotextile manufacturer's affidavit providing assurance that the qualifications of the Geotextile Manufacturer have been achieved.

B. A project reference list consisting of the principal details of at least 10 projects totaling at least 8 million square feet of installed geotextile.

C. Geotextile manufacturer’s specifications.

D. Mill certificate from the company manufacturing the geotextile confirming that the fibers and geotextile meet the chemical, physical, and manufacturing requirements specified.

E. Geotextile Manufacturer's Quality Assurance/Quality Control (QA/QC) certifications for each shipment of geotextile to verify that the materials supplied for the project are in accordance with the requirements of this specification. The certificates shall show the following:

1. Unit weight per ASTM D-5261
2. Grab tensile strength and elongation per ASTM D-4632
3. Trapezoidal tear strength per ASTM D-4533
4. CBR Puncture resistance per ASTM D-6241
5. Apparent opening size per ASTM D-4751

6. Permittivity, permeability, and water flow per ASTM D-4491

7. Ultraviolet light resistance per ASTM D-4355

8. Thickness per ASTM D-5199

F. Manufacturer's warranty covering materials and workmanship of the geotextile.

G. A project reference list from the Geotextile Installer consisting of the principal details of at least 10 projects totaling at least 1 million square feet of installed geotextile or satisfactory evidence through similar experience.

H. Survey data for the location, measurement, and payment of the geotextile.

1.04 QUALIFICATIONS

A. Geotextile Manufacturer must have produced at least 10 million square feet of non-woven geotextile, with at least 8 million square feet installed.

B. Geotextile Sub-Contractor must either have installed at least 1 million square feet of non-woven geotextile, or must provide to the Engineer satisfactory evidence, through similar experience in the installation of other types of geosynthetics, that the non-woven geotextile will be installed in a competent, professional manner.

PART 2 - PRODUCTS

2.01 NON-WOVEN GEOTEXTILE

A. Non-Woven Geotextile

The non-woven geotextile shall meet the physical requirements below. The geotextile shall be free of holes, tears, defects, and patch-repairs of defects. The geotextile shall be composed of a non-woven needle-punched, discontinuous fiber. Fibers used in manufacture of the geotextile, and threads used in joining the geotextiles by sewing, shall consist of long chain synthetic polymers composed of at least 95 percent by weight polyolefins, polyesters, or polyamides.

The geotextile and threads used in sewing the geotextile shall be chemically resistant to biological degradation, naturally encountered alkalis and acids, rot, and mildew. The geotextile and threads used in sewing the geotextile shall also contain stabilizers or inhibitors to limit degradation due to ultraviolet (UV) light exposure. Polymeric thread used for sewing shall exhibit chemical and UV resistance equal to or exceeding that of the geotextile.

B. Materials

The non-woven geotextile shall achieve compliance with the properties listed below. All values are minimum roll values in weaker principal direction unless indicated

otherwise.

PROPERTY	TEST METHOD	NON-WOVEN GEOTEXTILE
Fabric Weight (oz/yd^2)	ASTM D-5261	16
Thickness (mils)	ASTM D-5199	175
Grab Strength (lbs)	ASTM D-4632	425
Grab Elongation (%)	ASTM D-4632	50
Trapezoid Tear Strength (lbs)	ASTM D-4533	145
CBR Puncture Resistance (lbs)	ASTM D-6241	1200
Water Flow Rate (gpm/ft^2)	ASTM D-4491	45
Permittivity, Ψ (sec^{-1})	ASTM D-4491	0.57
Permeability, k (cm/sec)	ASTM D-4491	0.25
AOS (U.S. Sieve No.)	ASTM D-4751	100
U.V. Resistance (%)	ASTM D-4355	70% after 500 hours of exposure

C. Product Documentation

The Geotextile Sub-Contractor shall provide the Engineer with the QA/QC certifications for each shipment of non-woven geotextile. The certification shall be signed by a responsible party employed by the manufacturer such as the QA/QC Manager, Production Manger, or Technical Services Manager. The QA/QC certifications shall include:

1. Geotextile lot and roll numbers (with corresponding shipping information).
2. Manufacturer test data for raw materials used in the non-woven geotextile production, including those items listed in Article 1.03 D.
3. Manufacturer's test data for finished non-woven geotextile production, including those items listed in Article 1.03 E.

D. Product Labeling

Prior to shipment, the non-woven geotextile manufacturer shall affix a label to each roll identifying the following characteristics:

1. Product identification information (manufacturer name and address, brand name, product code).
2. Lot and roll number.

3. Roll length and width.

4. Total roll weight.

E. Packaging

1. The non-woven geotextile shall be wound around a cardboard core four (4) inches in diameter to facilitate handling. The core is not intended to support the roll for lifting, but shall be sufficiently strong to prevent collapse during transit.

2. All rolls shall be labeled and bagged in packaging that is resistant to photodegradation by ultraviolet light.

PART 3 - EXECUTION

3.01 SHIPPING AND HANDLING

A. The manufacturer assumes responsibility for initial loading and shipping of the non-woven geotextile. Unloading, on-site handling, and storage are the responsibility of the Geotextile Sub-Contractor.

B. Handling of rolls of non-woven geotextiles shall be done in a competent manner, such that damage does not occur to the non-woven geotextile nor to its protective wrapping.

C. The party responsible for unloading the non-woven geotextile shall contact the manufacturer prior to shipment to ascertain the appropriateness of the proposed unloading methods and equipment to be utilized.

D. A visual inspection of each roll shall be made as it is unloaded to identify if any packaging has been damaged. Rolls with damaged packaging shall be marked and set aside for further inspection. The packaging shall be repaired prior to being placed in storage.

3.02 SITE STORAGE

A. The location of field storage shall not be in areas where water can accumulate. The rolls shall be elevated off of the ground so as not to form a dam creating the ponding of water. A dedicated area shall be selected at the job site that is away from high traffic areas and well-drained.

B. Unloading of rolls or pallets at the job site's temporary storage location shall be such that no damage to the geotextile occurs.

C. Pushing, sliding, or dragging of rolls of non-woven geotextiles shall not be permitted.

D. The rolls shall be stacked in such a manner as to prevent crushing of the cores, sliding or rolling from the stacks, or damage to the non-woven geotextile.

E. Outdoor storage of rolls shall not exceed manufacturer's recommendations or longer than six (6) months, whichever is less. For storage periods longer than six (6) months a temporary enclosure shall be placed over the rolls, or they shall be moved within an enclosed facility.

3.03 PLACEMENT

A. The non-woven geotextile shall be placed at the locations shown in the Drawings.

B. Geotextiles shall be deployed free of wrinkles and folds.

C. During installation on slopes, the geotextiles shall be anchored at the top and rolled down the slope.

D. All geotextiles shall be weighted with sandbags or other material that will not damage the geotextile during the presence of wind. Geotextiles uplifed by wind may be reused upon approval by the Engineer.

E. The Geotextile Sub-Contractor shall take the necessary precautions to protect the underlying layers upon which the geotextile will be placed.

F. Trimming of the geotextiles shall be performed using only an upward cutting hook blade. Trimming of the geotextile shall be performed in a manner that will not damage the geomembrane or other underlying materials.

G. A visual examination shall be carried out over the installed non-woven geotextile to ensure that no potentially harmful objects are present such as small tools, sharp objects, or protruding stones.

3.04 SEAMING AND JOINING

A. The non-woven geotextile shall be overlapped and sewn together per the manufacturer's recommendations. The minimum overlap shall be one (1) inch.

B. All seams shall be continuously sewn. On slopes greater than 10:1, all seams shall be oriented parallel to the slope.

C. On slopes less than or equal to 10:1, damaged areas of a size exceeding 10 percent of the roll width shall be removed and replaced across the entire roll width with new material. Damaged areas of a size less than 10 percent of the roll width may be patched.

D. On slopes greater than 10:1, geotextile panels which require repair shall be removed and replaced with new material.

E. The thread used shall consist of high strength polypropylene or polyester. The sewn thread shall be of contrasting color to the non-woven geotextile and of chemical and ultraviolet properties equal to or greater than that of the geotextile.

3.05 DAMAGE REPAIR

A. Damaged non-woven geotextiles and non-woven geotextiles contaminated with dirt shall be repaired immediately at no additional cost to the Engineer.

B. The patch material used for the repair of a hole or tear shall be the same type of material as the damaged non-woven geotextile.

C. All patches shall extend at least 12 inches in all directions beyond any portion of the damaged geotextile.

D. The repair patch shall be sewn in place by hand or machine so as not to accidentally shift out of position or be moved during backfilling or covering operation.

E. The sewn thread shall be of contrasting color to the geotextile and of chemical and ultraviolet light resistance properties equal to or greater than that of the geotextile.

F. The repair shall be reviewed by the Engineer.

3.06 BACKFILLING OR COVERING

A. Covering of the non-woven geotextile shall be done in a controlled manner so as to not shift the geotextile from its intended position.

B. Covering material shall not be dropped on the non-woven geotextile in a manner that may puncture or damage the geotextile.

END OF SECTION

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SPECIFICATION REVISION INDEX

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SECTION 02777

GEOMEMBRANE LEAK LOCATION SURVEY

PART 1: GENERAL

1.1 SUMMARY

A. Requirements for performance of a geomembrane leak location survey using electrical methods for post-geomembrane installation performance for a single geomembrane underlain by earth materials.

B. Requirement to perform a geomembrane leak location survey before subsequent materials are placed on the geomembrane.

C. The optimum performance of a geomembrane leak location survey using electrical methods requires an electrically conductive media above and below the geomembrane to be electrically isolated from each other except through the leaks being located in the geomembrane. It is also necessary to have a continuous electrically conducting pathway through an electrically conducting material above the geomembrane, through the leaks, and through an electrically conducting media under the geomembrane. The Geomembrane Installer shall design and install any electrical conductive material required to conduct this testing that are not presented on the design drawings. Any additional materials shall be approved by the General Contractor prior to construction.

1.2 RELATED SECTIONS

A. Section 02372 – HDPE Geomembrane Liner

1.3 REFERENCES

A. ASTM D6747 – Standard Guide for Selection of Techniques for Electrical Detection of Potential Leak Paths in Geomembranes

B. ASTM D7002 – Standard Practice for Leak Location on Exposed Geomembranes Using the Water Puddle System

1.4 SUBMITTALS

A. Leak Location Sub-Contractor shall submit a Leak Location Survey Work Plan to Engineer for approval prior to commencement of any construction activities. The Leak Location Survey Work Plan shall include:

1. Qualifications of Testing Technician Sub-Contractor to include the number of years Technician has performed the survey method;
2. Resumes of on-site supervisors;
3. Description of the survey method, and procedures;
4. Required site preparations;
5. Estimated duration of survey;
6. Quality control and field calibration procedures;

7. A list of projects demonstrating the qualifications and experience where Technician and leak location supervisor have met the requirements of paragraph 2.1 of this section.
8. Sample of a final report (per ASTM D7002) provided by Testing Technician Sub-Contractor following the completion of the survey.
9. Any additional electrical conductive materials to be installed during construction that are required to successfully complete the leak location survey.

1.5 CONSTRUCTION QUALITY ASSURANCE

A. The leak location survey shall be observed by the General Contractor.

PART 2: PRODUCTS

2.1 LEAK LOCATION SUB-CONTRACTOR AND SUPERVISOR QUALIFICATIONS

A. Leak Location Sub-Contractor shall have qualifications and experience in conducting the survey method including having tested a minimum of 20,000,000 square feet of geomembrane liner within the previous three years. In addition, the leak location surveys must be supervised by a professional or technician with a minimum of three years and 5,000,000 square feet of geomembrane testing experience using the leak location survey method. The leak location supervisor must be on site full-time during the performance of the leak location survey.

B. Leak Location Sub-Contractor shall furnish equipment for performing the Work that automatically records and stores the leak location survey data in electronic format at the time of data collection (continuous survey data recording) and that can be post-processed for data plotting and analysis.

PART 3: EXECUTION

3.1 SITE PREPARATION

A. Leak Location Sub-Contractor will identify actions required by General Contractor to prepare the site for the leak location survey.

B. General Contractor shall ensure that the materials below the geomembrane contain sufficient moisture to conduct a leak location survey. Typically, a moisture content of more than two percent by weight is sufficient to conduct the survey. If the geomembrane is installed on a desiccated (dusty) subgrade, or on a geotextile, it will be necessary to spray the geomembrane with water prior to the leak location survey to allow time for the subgrade at the leaks to be wetted.

3.2 EXECUTION

A. Leak Location Sub-Contractor shall inspect the site prior to commencing the survey to ensure all site preparations are completed and the site conditions are appropriate for conducting the leak location survey.

B. Any discrepancy in the required site preparations described in the Leak Location Survey Work Plan or site conditions shall be reported to General Contractor for corrective or appropriate action.

C. It is recognized that the leak location survey cannot be conducted in areas that are immediately adjacent to the edges of a single geomembrane or immediately adjacent to electrical conducting paths through or around the geomembrane such as earth ramps, metal pipes, battens, or concrete structures.

D. Conduct a leak location survey on the bare geomembrane using the procedures described in the latest version of ASTM Standard D7002.

E. Leak Location Sub-Contractor shall inform General Contractor and mark the locations of all identified or indicated leaks with flags, spray paint, or written coordinates.

3.4 REPORTING

A. Provide a written report within seven (7) calendar days of completion of the leak location survey field work as described in ASTM D7002.

END OF SECTION

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SECTION 02821

CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Chain-link fences.
2. Swing gates.
3. Privacy slats.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For each type of fence and gate assembly.

1. Include plans, elevations, sections, details, and attachments to other work.

C. Samples: For each exposed product and for each color and texture specified.

D. Delegated-Design Submittal: For structural performance of chain-link fence and gate frameworks, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Product certificates.

B. Product test reports.

C. Sample warranty.

1.5 WARRANTY

A. Special Warranty: General Contractor agrees to repair or replace components of chain-link fences and gates that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two (2) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01400 – Quality Control to design chain-link fence and gate frameworks.

B. Structural Performance: Chain-link fence and gate frameworks shall withstand the design wind loads and stresses for fence height(s) and under exposure conditions indicated according to [ASCE/SEI 7] <Insert requirement>:

1. Design Wind Load: [As indicated on Drawings] <Insert loads>.

a. Minimum Post Size: Determine according to ASTM F 1043 for post spacing not to exceed [10 feet (3 m)] <Insert dimension> for Material [Group IA, ASTM F 1043, Schedule 40 steel pipe] [Group IC, electric-resistance-welded round steel pipe] <Insert material group>.
b. Minimum Post Size and Maximum Spacing: Determine according to CLFMI WLG 2445, based on mesh size and pattern specified.

2.2 CHAIN-LINK FENCE FABRIC

A. General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist according to "CLFMI Product Manual" and requirements indicated below:

1. Fabric Height: <Insert dimension> [As indicated on Drawings].
2. Steel Wire for Fabric: Wire diameter of [0.192 inch (4.88 mm)] [0.148 inch (3.76 mm)] [0.120 inch (3.05 mm)] [0.113 inch (2.87 mm)] <Insert dimension>.

a. Mesh Size: [2-1/8 inches (54 mm)] [2 inches (50 mm)] [1-3/4 inches (44 mm)] [1 inch (25 mm)] <Insert dimension>.
b. Aluminum-Coated Fabric: ASTM A 491, Type I, [0.40 oz./sq. ft. (122 g/sq. m)] [0.35 oz./sq. ft. (107 g/sq. m)] [0.30 oz./sq. ft. (92 g/sq. m)].
c. Zinc-Coated Fabric: ASTM A 392, Type II, [Class 1, 1.2 oz./sq. ft. (366 g/sq. m)] [Class 2, 2.0 oz./sq. ft. (610 g/sq. m)] with zinc coating applied [before] [after] weaving.
d. Zn-5-Al-MM Aluminum-Mischmetal-Coated Fabric: ASTM F 1345, Type III, [Class 1, 0.60 oz./sq. ft. (183 g/sq. m)] [Class 2, 1.0 oz./sq. ft. (305 g/sq. m)].
e. Polymer-Coated Fabric: ASTM F 668, [Class 1] [Class 2a] [Class 2b] over [aluminum] [zinc] [Zn-5-Al-MM-alloy]-coated steel wire.

1) Color: [Dark green] [Olive green] [Brown] [Black] [As selected by Architect from manufacturer's full range], according to ASTM F 934.

f. Coat selvage ends of metallic-coated fabric before the weaving process with manufacturer's standard clear protective coating.

3. Aluminum Wire Fabric: ASTM F 1183, with [mill] [caustic-cleaned or etched] finish, and wire diameter of [0.148 inch (3.76 mm)] [0.192 inch (4.88 mm)].

a. Mesh Size: [2 inches (50 mm)] [1 inch (25 mm)].

4. Selvage: [Knuckled at both selvages] [Twisted top and knuckled bottom].

2.3 FENCE FRAMEWORK

A. Posts and Rails <Insert drawing designation>: ASTM F 1043 for framework, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F 1043 or ASTM F 1083 based on the following:

1. Fence Height: [72 inches (1830 mm)] [96 inches (2440 mm)] [As indicated on Drawings] <Insert dimension>.
2. Light-Industrial-Strength Material: [Group IC-L, round steel pipe, electric-resistance-welded pipe] [Group II-L, roll-formed-steel C-section shapes] [Group III-L, hot-rolled H-beam shapes] [Group IV, Alternative Design].

a. Line Post: [1.9 inches (48 mm) in diameter] [2.375 inches (60 mm) in diameter] [2.875 inches (73 mm) in diameter] [2.25 by 1.7 inches (57 by 43 mm)] <Insert dimension(s)>.
b. End, Corner, and Pull Posts: [2.375 inches (60 mm)] [2.875 inches (73 mm)] [4.0 inches (102 mm)] [2.25 by 1.7 inches (57 by 43 mm)] <Insert dimension(s)>.

3. Heavy-Industrial-Strength Material: [Group IA, round steel pipe, Schedule 40] [Group IC, round steel pipe, electric-resistance-welded pipe] [Group II, roll-formed-steel C-section shapes] [Group III, hot-rolled H-beam shapes] [Group IV, Alternative Design].

a. Line Post: [1.9 inches (48 mm) in diameter] [2.375 inches (60 mm) in diameter] [2.875 inches (73 mm) in diameter] [4.0 inches (102 mm) in diameter] [6.625 inches (168 mm) in diameter] [1.875 by 1.63 inches (48 by 41 mm)] [2.25 by 1.70 inches (57 by 43 mm)] [3.25 by 2.50 inches (83 by 64 mm)] <Insert dimension(s)>.
b. End, Corner, and Pull Posts: [2.375 inches (60 mm) in diameter] [2.875 inches (73 mm) in diameter] [4.0 inches (102 mm) in diameter] [6.625 inches (168 mm) in diameter] [2.25 by 1.70 inches (57 by 43 mm)] [3.25 by 2.50 inches (83 by 64 mm)] <Insert dimension(s)>.

4. Horizontal Framework Members: [Intermediate] [top] [and] [bottom] rails according to ASTM F 1043.
5. Brace Rails: ASTM F 1043.
6. Metallic Coating for Steel Framework:

a. Type A zinc coating.
b. Type B zinc with organic overcoat.

c. External, Type B zinc with organic overcoat and internal, Type D zinc-pigmented coating.
d. Type C, Zn-5-Al-MM alloy coating.
e. Coatings: Any coating above.

7. Polymer coating over metallic coating.

a. Color: [Match chain-link fabric] [Dark green] [Olive green] [Brown] [Black] [As selected by Architect from manufacturer's full range], according to ASTM F 934.

2.4 TENSION WIRE

A. Metallic-Coated Steel Wire: 0.177-inch- (4.5-mm-) diameter, marcelled tension wire according to ASTM A 817 or ASTM A 824, with the following metallic coating:

1. Type I: Aluminum coated (aluminized).
2. Type II: Zinc coated (galvanized) with minimum coating weight matching chain-link fabric coating weight.
3. Type III: Zn-5-Al-MM alloy with the following minimum coating weight matching chain-link fabric coating weight.

B. Polymer-Coated Steel Wire: [0.177-inch- (4.5-mm-)] [0.148-inch- (3.8-mm-)] diameter, tension wire according to ASTM F 1664, [Class 1] [Class 2a] [Class 2b] over [aluminum] [zinc] [Zn-5-Al-MM-alloy]-coated steel wire.

1. Color: [Match chain-link fabric] [Dark green] [Olive green] [Brown] [Black] [As selected by Architect from manufacturer's full range], according to ASTM F 934.

2.5 SWING GATES

A. General: ASTM F 900 for gate posts and [single] [double] swing gate types.

1. Gate Leaf Width: [36 inches (914 mm)] [As indicated] <Insert width>.
2. Framework Member Sizes and Strength: Based on gate fabric height [of 72 inches (1830 mm) or less] [of more than 72 inches (1830 mm)] [as indicated] <Insert dimension>.

B. Pipe and Tubing:

1. Zinc-Coated Steel: ASTM F 1043 and ASTM F 1083; [protective coating and finish to match fence framework] [manufacturer's standard protective coating and finish] <Insert finish>.
2. Aluminum: ASTM B 429/B 429M; [mill] [manufacturer's standard] <Insert finish> finish.
3. Gate Posts: [Round tubular steel] [Rectangular tubular steel] [Round tubular aluminum] [Rectangular tubular aluminum].
4. Gate Frames and Bracing: [Round tubular steel] [Rectangular tubular steel] [Round tubular aluminum] [Rectangular tubular aluminum].

C. Frame Corner Construction: [Welded] [or] [assembled with corner fittings].

D. Extended Gate Posts and Frame Members: Fabricate gate posts and frame end members to extend [12 inches (300 mm)] [as indicated] <Insert dimension> above top of chain-link fabric at both ends of gate frame to attach barbed wire assemblies.

E. Hardware:

1. Hinges: [180-degree inward] [180-degree outward] [360-degree inward and outward] swing.
2. Latch: Permitting operation from both sides of gate[with provision for padlocking accessible from both sides of gate].
3. Lock: [Manufacturer's standard] <Insert requirement> internal device.
4. Padlock and Chain: <Insert requirements>.
5. Closer: [Manufacturer's standard] <Insert requirement>.
6. <Insert hardware items and accessories>.

2.6 FITTINGS

A. Provide fittings according to ASTM F 626.

B. Barbed Wire Arms: [Pressed steel or cast iron] [Aluminum], with clips, slots, or other means for attaching strands of barbed wire[, and means for attaching to posts] [, integral with post cap], for each post unless otherwise indicated, and as follows:

1. Provide line posts with arms that accommodate top rail or tension wire.
2. Provide corner arms at fence corner posts unless extended posts are indicated.
3. Single-Arm Type: [Type I, slanted arm] [Type II, vertical arm].
4. Double-Arm Type: [Type III, V-shaped arm] [Type IV, A-shaped arm].

C. Finish:

1. Metallic Coating for Pressed Steel or Cast Iron: Not less than 1.2 oz./sq. ft. (366 g/sq. m) of zinc.

    a. Polymer coating over metallic coating.

2. Aluminum: Mill finish.

2.7 PRIVACY SLATS

A. Fiber-Glass-Reinforced Plastic Slats: UV-light-stabilized fiber-glass-reinforced plastic, not less than 0.06 inch (1.5 mm) thick, sized to fit mesh specified for direction indicated[, with vandal-resistant fasteners and lock strips].

B. Tubular Polyethylene Slats: Minimum 0.023-inch (0.58-mm)-thick tubular polyethylene, manufactured for chain-link fences from virgin polyethylene with UV inhibitor, sized to fit mesh specified for direction indicated, with [vandal-resistant fasteners and lock strips] [fins for increased privacy factor].

C. Hedge-Type Slats: UV-light-stabilized[, flame-resistant], PVC "needles" woven into braided, galvanized wire core, sized to fit mesh specified for direction indicated.

D. Color: [As indicated by manufacturer's designations] [Match Architect's samples] [As selected by Architect from manufacturer's full range] [As indicated on Drawings] <Insert color>.

2.8 BARBED WIRE

A. Steel Barbed Wire: ASTM A 121, two-strand barbed wire, 0.099-inch- (2.51-mm-) diameter line wire with 0.080-inch- (2.03-mm-) diameter, four-point round barbs spaced not more than 5 inches (127 mm) o.c.

1. Aluminum Coating: Type A.
2. Zinc Coating: Type Z, Class 3.

B. Polymer-Coated, Galvanized-Steel Barbed Wire: ASTM F 1665, two-strand barbed wire, 0.080-inch- (2.03-mm-) diameter line wire with 0.080-inch- (2.03-mm-) diameter, four-point, round [aluminum alloy] [galvanized-steel] barbs spaced not more than 5 inches (127 mm) o.c.:

1. Polymer Coating: [Class 1] [Class 2a] [Class 2b] over [aluminum] [zinc] [Zn-5-Al-MM-alloy]-coated steel wire.

a. Color: [Match chain-link fabric] [Dark green] [Olive green] [Brown] [Black] [As selected by Architect from manufacturer's full range] according to ASTM F 934.

2.9 GROUT AND ANCHORING CEMENT

A. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout, recommended in writing by manufacturer, for exterior applications.

B. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating, and that is recommended in writing by manufacturer for exterior applications.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Do not begin installation before final grading is completed unless otherwise permitted by Engineer.

3.2 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 CHAIN-LINK FENCE INSTALLATION

A. Install chain-link fencing according to ASTM F 567 and more stringent requirements specified.

B. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.

C. Post Setting: Set posts [in concrete] [with mechanical anchors] [by mechanically driving into soil] at indicated spacing into firm, undisturbed soil.

1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
2. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.

    a. Exposed Concrete: Extend 2 inches (50 mm) above grade; shape and smooth to shed water.
    b. Concealed Concrete: Place top of concrete 2 inches (50 mm) below grade to allow covering with surface material.
    c. Posts Set into Sleeves in Concrete: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts are inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout or anchoring cement, mixed and placed according to anchoring material manufacturer's written instructions. Finish anchorage joint to slope away from post to drain water.
    d. Posts Set into Holes in Concrete: Form or core drill holes not less than 5 inches (127 mm) deep and 3/4 inch (20 mm) larger than OD of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout or anchoring cement, mixed and placed according to anchoring material manufacturer's written instructions. Finish anchorage joint to slope away from post to drain water.

3. Mechanically Driven Posts: Drive into soil to depth of [30 inches (762 mm)] [36 inches (914 mm)] <Insert dimension>. Protect post top to prevent distortion.

D. Terminal Posts: Install terminal end, corner, and gate posts according to ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment of [15 degrees or more] [30 degrees or more] [as indicated on Drawings] <Insert requirement>. For runs exceeding 500 feet (152 m), space pull posts an equal distance between corner or end posts.

E. Line Posts: Space line posts uniformly at [96 inches (2440 mm)] [10 feet (3 m)] <Insert dimension> o.c.

F. Tension Wire: Install according to ASTM F 567, maintaining plumb position and alignment of fence posts. Pull wire taut, without sags. Fasten fabric to tension wire with 0.120-inch- (3.05-

mm-) diameter hog rings of same material and finish as fabric wire, spaced a maximum of 24 inches (610 mm) o.c. Install tension wire in locations indicated before stretching fabric. Provide horizontal tension wire at the following locations:

1. Extended along [top] [and] [bottom] of fence fabric.
2. [As indicated on Drawings] <Insert requirements>.

G. Chain-Link Fabric: Apply fabric to [outside] [inside] of enclosing framework. Leave [1-inch (25-mm)] [2-inch (50-mm)] bottom clearance between finish grade or surface and bottom selvage unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.

H. Privacy Slats: Install slats in direction indicated, securely locked in place.

1. [Vertically] [Horizontally][, for privacy factor of 70 to 75] <Insert privacy factor range>.
2. Diagonally[for privacy factor of 80 to 85] <Insert privacy factor range>.
3. Direction[and privacy factor] as indicated on Drawings.

I. Barbed Wire: Install barbed wire uniformly spaced[, angled toward security side of fence] [as indicated on Drawings]. Pull wire taut, install securely to extension arms, and secure to end post or terminal arms.

3.4 ADJUSTING

A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Lubricate hardware and other moving parts.

END OF SECTION

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TETRA TECH	**Turf and Grasses** **Technical Specification**	**SPECIFICATION NUMBER: 02924** **PROJECT NUMBER: 117-7502016-L09** **PROJECT NAME: Weir Dewatering Treatment**

SPECIFICATION REVISION INDEX

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SECTION 02924

TURF AND GRASSES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Seeding.
2. Sodding.

1.2 DEFINITIONS

A. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

B. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See [Section 329113 "Soil Preparation"] [Section 329115 "Soil Preparation (Performance Specification)"] and drawing designations for planting soils.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [Project site] <Insert location>.

1.4 INFORMATIONAL SUBMITTALS

A. Certification of grass seed.

1. Certification of each seed mixture for turfgrass sod.

B. Product certificates.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful turf establishment.

1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.

2. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the Professional Landcare Network:

    a. Landscape Industry Certified Technician - Exterior.
    b. Landscape Industry Certified Lawncare Manager.
    c. Landscape Industry Certified Lawncare Technician.

3. Pesticide Applicator: State licensed, commercial.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.

B. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" sections in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod within 24 hours of harvesting and in time for planting promptly. Protect sod from breakage and drying.

PART 2 - PRODUCTS

2.1 SEED

A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Rules for Testing Seeds" for purity and germination tolerances.

B. Seed Species:

1. Quality: State-certified seed of grass species as listed below for solar exposure.
2. Quality: Seed of grass species as listed below for solar exposure, with not less than [85] <Insert number> percent germination, not less than [95] <Insert number> percent pure seed, and not more than [0.5] <Insert number> percent weed seed:
3. Full Sun: <Insert species>.
4. Sun and Partial Shade: Proportioned by weight as follows:

    a. <Insert number> percent <Insert species>.
    b. <Insert number> percent <Insert species>.
    c. <Insert number> percent <Insert species>.

5. Shade: Proportioned by weight as follows:

    a. <Insert number> percent <Insert species>.
    b. <Insert number> percent <Insert species>.
    c. <Insert number> percent <Insert species>.

C. Grass-Seed Mix: Proprietary seed mix as follows:

1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:

    a. <Insert manufacturer's name; product name or designation>.

2.2 TURFGRASS SOD

A. Turfgrass Sod: [Certified] [Approved] [Number 1 Quality/Premium, including limitations on thatch, weeds, diseases, nematodes, and insects], complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture that is strongly rooted and capable of vigorous growth and development when planted.

B. Turfgrass Species: Sod of grass species as follows:

1. Full Sun: <Insert species>.
2. Sun and Partial Shade: Proportioned by weight as follows:

    a. <Insert number> percent <Insert species>.
    b. <Insert number> percent <Insert species>.
    c. <Insert number> percent <Insert species>.

3. Shade: Proportioned by weight as follows:

    a. <Insert number> percent <Insert species>.
    b. <Insert number> percent <Insert species>.
    c. <Insert number> percent <Insert species>.

2.3 FERTILIZERS

A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition: [1 lb/1000 sq. ft. (0.45 kg/92.9 sq. m)] <Insert value> of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.

B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.

2.4 MULCHES

A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

B. Sphagnum Peat Mulch: Partially decomposed sphagnum peat moss, finely divided or of granular texture, and with a pH range of 3.4 to 4.8.

C. Muck Peat Mulch: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture, with a pH range of 6 to 7.5, and having a water-absorbing capacity of 1100 to 2000 percent, and containing no sand.

D. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch (25-mm) sieve; soluble salt content of [2 to 5] <Insert range or value> decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

2.5 PESTICIDES

A. General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

PART 3 - EXECUTION

3.1 TURF AREA PREPARATION

A. General: Prepare planting area for soil placement and mix planting soil according to [Section 329113 "Soil Preparation."] [Section 329115 "Soil Preparation (Performance Specification)."]

B. Reduce elevation of planting soil to allow for soil thickness of sod.

C. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

D. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.2 SEEDING

A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph (8 km/h).

1. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
2. Do not use wet seed or seed that is moldy or otherwise damaged.
3. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.

B. Sow seed at a total rate of [2 lb/1000 sq. ft. (0.9 kg/92.9 sq. m)] [3 to 4 lb/1000 sq. ft. (1.4 to 1.8 kg/92.9 sq. m)] [5 to 8 lb/1000 sq. ft. (2.3 to 3.6 kg/92.9 sq. m)] <Insert values>.

C. Rake seed lightly into top 1/8 inch (3 mm) of soil, roll lightly, and water with fine spray.

D. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of [2 tons/acre (42 kg/92.9 sq. m)] <Insert values> to form a continuous blanket [1-1/2 inches (38 mm)] <Insert dimension> in loose thickness over seeded areas.

1. Anchor straw mulch by crimping into soil with suitable mechanical equipment.

E. Protect seeded areas from hot, dry weather or drying winds by applying [compost mulch] [peat mulch] [planting soil] within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of [3/16 inch (4.8 mm)] <Insert dimension>, and roll surface smooth.

3.3 SODDING

A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.

B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to soil or sod during installation. Tamp and roll lightly to ensure contact with soil, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.

1. Lay sod across slopes exceeding 1:3.
2. Anchor sod on slopes exceeding 1:6 with wood pegs or steel staples spaced as recommended by sod manufacturer but not less than two anchors per sod strip to prevent slippage.

C. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches (38 mm) below sod.

3.4 TURF MAINTENANCE

A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.

B. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than one-third of grass height. Remove no more than one-third of grass-leaf growth in initial or subsequent mowings.

3.5 SATISFACTORY TURF

A. Turf installations shall meet the following criteria as determined by Architect:

1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding [90 percent over any 10 sq. ft. (0.92 sq. m) and bare spots not exceeding 5 by 5 inches (125 by 125 mm)] <Insert coverage>.
2. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.

B. Use specified materials to reestablish turf that does not comply with requirements, and continue maintenance until turf is satisfactory.

END OF SECTION

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SPECIFICATION REVISION INDEX

Revision No.	Revision Date	Issued for	Signatures				
			Prepared By	Reviewed By	Project Engineer	Project Manager	Client
A	11/28/2016	60% Submittal	SAB		JG	STD	
B	1/27/2017	DRAFT 90% Submittal	SAB		JG	STD	
C	2/15/2017	75% Submittal	SAB		JG	STD	

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SECTION 03000

CONCRETE

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Cast-in-place concrete

B. Reinforcing steel

C. Forms

D. Concrete accessories

1.2 RELATED SECTIONS

A. Section 01010—Summary of Work

B. Section 01400—Quality Control

C. Section 03600—Grout

D. Section 05501—Anchor Bolts and Expansion Anchors

1.3 REFERENCES

A. ACI 214—Recommended Practice for Evaluating Compression Test Results of Field Concrete

B. ACI 301—Structural Concrete for Buildings

C. ACI 302—Recommended Practice for Concrete Floor and Slab Construction

D. ACI 304—Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete

E. ACI 305/305R—Hot Weather Concreting

F. ACI 306/306R—Cold Weather Concreting

G. ACI 308—Standard Practice for Curing Concrete

H. ACI 309—Standard Practice for Consolidation of Concrete

I. ACI 315—Manual of Standard Practice for Detailing Reinforced Concrete Structures

J. ACI 318—Building Code Requirements for Reinforced Concrete

K. ACI 347—Recommended Practice for Concrete Formwork

L. ACI 350R—Environmental Engineering Concrete Structures

M. ACI SP-66—American Concrete Institute—Detailing Manual

N. ASTM A82—Cold Drawn Steel Wire for Concrete Reinforcement

O. ASTM A185—Welded Steel Wire Fabric for Concrete Reinforcement

P. ASTM A497—Welded Deformed Steel Wire Fabric for Concrete Reinforcement

Q. ASTM A615—Deformed and Plain Billet Steel Bars for Concrete Reinforcement

R. ASTM C31—Making and Curing Concrete Test Specimens in the Field

S. ASTM C33—Concrete Aggregates

T. ASTM C39—Test Method for Compressive Strength of Cylindrical Concrete Specimens

U. ASTM C94—Ready-Mixed Concrete

V. ASTM C143—Test Method for Slump of Hydraulic Cement Concrete

W. ASTM C150—Standard Specification for Portland Cement

X. ASTM C171—Sheet Materials for Curing Concrete

Y. ASTM C260—Air Entraining Admixtures for Concrete

Z. ASTM C309—Liquid Membrane-Forming Compounds for Curing Concrete

AA. ASTM C494—Chemical Admixtures for Concrete

BB. ASTM C618—Fly Ash and Raw or Calcinated Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete

CC. ASTM D994—Preformed Expansion Joint Filler for Concrete (Bituminous Type)

DD. ASTM D1190—Concrete Joint Sealer, Hot-Poured Elastic Type

EE. ASTM D1751—Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)

FF. ASTM D1752—Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction

GG. ASTM D2103—Polyethylene Film and Sheeting

HH. CRSI—Concrete Reinforcing Steel Institute—Manual of Practice

II. CRSI 63—Recommended Practice for Placing Reinforcing Bars

JJ. CRSI 65—Recommended Practice for Placing Bar Supports, Specifications and Nomenclature

KK. PS 1—Construction and Industrial Plywood

1.4 PERFORMANCE TOLERANCES

A. Conform to ACI 301, ACI 347, and ACI 350 as modified herein. In case of conflict, ACI 350 governs.

1.5 SUBMITTALS

A. Shop Drawings: Submit Reinforcing bar lists, fabrication and placement drawings to the Engineer:
   1. Indicate bar sizes, spacings, locations, and quantities of reinforcing steel bending and cutting schedules
   2. Indicate pertinent dimensions, materials, bracing, and arrangement of joints and ties

B. Product Data to be submitted to the Engineer: Provide sufficient information on products specified to verify compliance with specifications. Provide data on void form materials, joint devices, and attachment accessories.

C. Test Reports to be submitted to the Engineer:
   1. Submit reports of tentative concrete mix design and testing including:
      a. Slump range on which the design is based
      b. Total gallons of water per cubic yard
      c. Brand, type, composition, and quantity of cement with manufacturer and plant location identified
      d. Brand, type, composition and quantity of fly ash
      e. Specific gravity and gradation of fine and coarse aggregates
      f. Ratio of fine to total aggregates
      g. Surface-dry weight of each aggregate per cubic yard

h. Brand, type, ASTM designation, active chemical ingredients and quantity of each admixture
i. Air content and tolerance
j. Water/cementitious material ratio and tolerance
k. Compressive strength based at 7- and 28-day compression tests
l. Time of initial set

2. Submit reports of field quality control testing
3. Submit suppliers certified fly ash test reports for each shipment delivered to concrete supplier:
   a. Physical and chemical characteristics
   b. Certification of compliance with the specifications
   c. Signed by Tank Supplier and concrete supplier
4. Existing data on proposed design mixes are acceptable if certified and complete

1.6 QUALITY ASSURANCE

A. Perform work in accordance with ACI 301 and ACI 350

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

1.7 DELIVERY, STORAGE, AND HANDLING

A. Cement and fly ash: Store in moisture proof enclosures, do not use if caked or lumpy

B. Aggregate: Store to prevent segregation and inclusion of foreign materials, do not use the bottom 6 inch of piles in contact with the ground

C. Reinforcing steel: Store on supports which will keep it from contact with the ground and cover to prevent unacceptable surface corrosion and contamination

D. Rubber and plastic materials: Store in a cool place, do not expose to direct sunlight

E. Prepare a delivery ticket for each load of ready-mixed concrete

F. Truck operator shall hand ticket to General Contractor at the time of delivery with ticket to show:
   1. Quantity delivered
   2. Actual quantity of each material in batch
   3. Outdoor temperature in the shade
   4. Time at which cement was added
   5. Numerical sequence of the delivery
   6. Quantity of water that can be added in the field based on mix design
   7. Free moisture in fine and coarse aggregate in percent by weight
   8. Temperature of batch at time of delivery

9. Brand, ASTM designation, quantity and time of application for all chemical admixtures included in each batch

PART 2 PRODUCTS

2.1 FORMS

A. Prefabricated: The Burke Company "Burke Forming System," Simplex "Industrial Steel Frame Forms", Symons "Steel-Ply", Universal "Uniform", or approved equal

B. Plywood: PS 1, waterproof resin-bonded, exterior type Douglas Fir; face adjacent to concrete Grade B or better

C. Fiberboard: FS LL-B-810, Type IX, tempered, waterproof, screen back, concrete form hardboard

D. Lumber: Straight, uniform width and thickness and free from knots, offsets, holes, dents, and other surface defects

E. Chamfer strips: Clear, white pine, surface against concrete planed

F. Form coating: The Burke Company "Burke Release #1," Industrial lubricants "Nox-Crete Form Coating", L & M "Debond", Protex "Pro-Cote", Richmond "Rich Cote", or approved equal

G. Form ties: Removable end, permanently embedded body types with waterstops not requiring auxiliary spreaders, with cones on both ends, embedded portion 1 inch minimum back from concrete face. If not provided with threaded ends, constructed for breaking off ends without damage to concrete. The Burke Company "Burke Penta-Tie System" or equal

2.2 REINFORCING STEEL

A. Bars: ASTM A615, Grade 60

B. Beam stirrups and column ties: ASTM A615, Grade 60

C. Column spirals: ASTM A82

D. Welded wire fabric: ASTM A185 or A497

E. Bar supports: PS 7; CRSI Class B or E, fabricated from galvanized wire having PVC coated legs

F. Tie wire: 16-1/2 gage or heavier, black annealed wire

2.3 CONCRETE

A. As indicated on the Design Drawings.

B. Cement: ASTM C150, Type I/II

C. Fly ash: ASTM C618, Class C or Class F, except loss on ignition not more than 5%

D. Fine aggregate: Clean, natural sand, ASTM C33; no manufactured or artificial sand

E. Coarse aggregate: Crushed rock, natural gravel, or other inert granular material, ASTM C33 except clay and shale particles no more than 1 percent. Free of all materials deleteriously reactive with alkalies in the cement in an amount to cause excessive expansion of concrete

F. Water: Clean and free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances that may be deleterious to concrete or steel. Provide mixing water free from deleterious amounts of chloride ion for prestressed concrete or for concrete which will contain aluminum embedments including that portion of the mixing water contributed in the form of free moisture on the aggregates

G. Admixtures:
   1. Acceleration: High range water reducer
   2. Retarder: ASTM C494, Type D; Grace “Duratard-HC,” Master Builders “MC-HC”, Protex “Protard”, Sika Chemical “Plastiment”, or approved equal
   3. Plasticizer: ASTM C494, Type A; Grace “WRD A-HC,” "Sika Chemical “Plastocrete”, or approved equal
   4. Air entraining agent: ASTM C260; Grace “Darex AEA”, Master Builders “MB-VR”, Protex “AES”, Sika Chemical “AEK”, or approved equal

2.4 WATERSTOPS

A. Type I waterstops:
   1. Rubber: Dumbbell type, 6 inch wide by 3/8 inch thick with 3/4 inch bead on each edge, Sika Group, “WESTEC PE (polyethylene)”or approved equal

2.5 ACCESSORIES

A. Polyethylene film: ASTM C171, 6 mil minimum.

B. Expansion Joint Filler: ASTM D1751, asphalt impregnated fiber board sponge, 1/2 inch thickness unless indicated otherwise

C. Expansion and contraction joint shear bar grease: No-Ox-Id "A Special," axle grease, or approved equal

D. Membrane curing compound:
   1. General use: ASTM C309, Sonneborn "Sonosil" curing compound or approved equal
   2. Floor slabs: Sonneborn "Kure-N-Harden" concrete hardener and dust proofer, or approved equal. If floor slab is water cured, use Sonneborn "Lapidolith" or approved equal
   3. In chemical containment areas: Sonneborn "Kure-N-Harden" for chemicals listed on chemical resistance chart, or approved equal.

E. Vapor barrier: Polyethylene-coated reinforced paper, Sisalkraft "Mois-top", or approved equal

F. Bonding Admixture and Bonding Agent: Sika "Sikadur 32, Hi-Mod" bonding agent, or approved equal

2.6 MIXES

A. Design concrete mix within the limits specified on Design Drawings and as indicated below

B. Comply with ASTM C94

C. Cement Content:
   1. Minimum Portland cement, lbs per cu yd for concrete containing a water reducing admixture: Coarse Aggregate Size from No. 4 Sieve to

Concrete Slump	Sieve Size		
	½ inch	¾ inch	1 inch
2 inches	573	545	517
3 inches	592	564	536
4 inches	611	583	555

2. General Contractor shall have the option to substitute fly ash for 15 – 20 percent of cement at a ratio of the specific gravity of cement divided by specific gravity of fly ash

D. Water/Cementitious Material (Cement and Fly Ash) Ratio: Less than or equal to 0.45

E. Maximum Slump:
1. 4 inch without plasticizer admixture
2. As low as possible consistent with proper handling and thorough compaction

F. Bearing Pads:
1. Neoprene: Durometer 50, minimum 1/2 inch thick

G. Volume Ratio of Fine to Total Aggregates:

Coarse Aggregate Size	Minimum Ratio	Maximum Ratio
1/2 inch	0.40	0.55
3/4 inch	0.35	0.50
1 inch	0.30	0.46

H. Initial Set: 5-1/2 hrs $\forall$ 1 hr after water and cement are added to the aggregates as determined by ASTM C403:
1. Adjust retarder or accelerator quantities to compensate for temperature and job condition variations

I. Volumetric Air Content:
1. Maximum 5 percent $\pm$ 1.5 percent after placement
2. Vary air content with maximum aggregate, ASTM C94, Table 3
3. Air may be omitted from interior slabs to be trowel finished

J. Admixtures: Content, batching method, and time of introduction in accordance with the manufacturer's recommendations for compliance with this specification:
1. Include a water reducing admixture
2. Calcium chloride content shall not exceed 0.05 percent of the cement content by weight

K. Strength: Compressive strength as determined by ASTM C39

Age	Minimum Strength
7 days	3,000 psi
28 days	4,500 psi

L. Consistency: Uniform slump, suitable for the placement conditions with aggregate floating uniformly throughout the concrete mass, flowing sluggishly when vibrated or spaded

M. Adjust mix as required to meet specifications

2.7 FABRICATION

A. Reinforcing Steel: Accurately formed, fabricated in accordance with ACI 315 and 318 except as specified or indicated on Drawings, free from rust, scale, and contaminants which will reduce bond

2.8 SOURCE QUALITY CONTROL

A. Test the proposed concrete mix for each size and gradation of aggregates and each consistency intended for use in the project
   1. Concrete used to create test samples shall have all specified admixtures included

B. Aggregates:
   1. Sample and test according to ASTM C33
   2. Determine bulk specific gravity in accordance with ASTM C127 and C128

C. Compression tests:
   1. Prepare 2 sets of compression test cylinders from each proposed concrete mix, 4 cylinders per set
   2. Test 1 set of 4 cylinders at 7 days, the other at 28 days
   3. Make, cure and store in accordance with ASTM C192
   4. Test in accordance with ASTM C39

D. Slump test: ASTM C143

E. Total air content: ASTM C231

F. Fly Ash: Supplier's chemical composition and physical analysis test

G. Initial set test:
   1. In accordance with ASTM C403
   2. Test at 70 degrees F and 90 degrees F ambient
   3. Test at 70 degrees F on mix including specific plasticizing and entraining admixtures
   4. Test at 90 degrees F on mix including specified retarding and air entraining admixtures
   5. Fly ash: Supplier's chemical composition and physical analysis test

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify site conditions under provisions of Section 01010

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 FORMS

A. Design to produce hardened concrete to the shape, lines, and dimensions indicated on the drawings

B. Conform to ACI 347 as modified herein

C. Surfaces exposed to view:
   1. Prefabricated plywood panel forms, job-built plywood forms, or forms lined with plywood or fiberboard
   2. Laid out in a regular and uniform pattern with long dimensions vertical and joints aligned
   3. Produce finished surfaces free from offsets, ridges, waves, and concave or convex areas
   4. Maximum deviation from a true plane: 1/8 inch within 6 feet

D. Plywood or lined forms are not required for surface normally submerged or not normally exposed to view

E. Other type of forms may be used for surfaces not restricted to plywood or lined forms as backing for form lining

F. Provide forms above all extended footings; flat segmental forms, 2 foot maximum width, may be used for curved surfaces 25 feet minimum diameter

G. Provide polyethylene film to protect concrete from water loss when placing concrete against gravel or crushed rock not containing 25 percent minimum material passing a No. 4 sieve, lap joint 4 inches

H. When placing concrete against rock, remove all loose pieces of rock and clean exposed surface with high pressure hose

I. Provide substantial forms sufficiently tight to prevent leakage of mortar

J. Brace or tie forms to maintain desired position, shape, and alignment during and after concrete placement

K. Size and space wailers, studs, internal ties, and other form supports so proper working stresses are not exceeded

L. Form concrete column supported beams and slabs so column forms may be removed without disturbing beam and slab form supports

M. Where the top of a wall will be exposed to weathering, stop form on at least 1 side at true line and grade

N. Locations to be finished to a specified elevation, slope, or contour, bring form to true line and grade and provide a wooden guide strip at the proper location in the forms for finishing the top surface with a screed or template

O. Provide temporary opening at the bottom of columns and wall forms and wherever necessary for cleaning and inspection

P. Install form ties on exposed surfaces in uniformly spaced vertical and horizontal rows

Q. Provide chamfer strips to bevel salient edges and corners. Do not provide for top edges of walls and slabs to be tooled or for edges to be buried

R. Do not remove or disturb until concrete has attained sufficient strength to safely support all dead and live loads

S. Leave shoring beneath beams and slabs in place and reinforce as required for construction equipment and materials

T. Maintain forms in place for a minimum of 48 hours of curing time

U. Remove forms carefully to prevent surface gouging, corner or edge breakage and other drainage

3.3 VAPOR BARRIERS

A. Install vapor barrier under interior slabs on grade. Lap joints minimum 6 inches and seal watertight by sealant applied between overlapping edges and ends

B. Seal joints in the film with waterproof sealing tape

C. Take care to prevent damaging the film

D. Inspect for damage immediately before the concrete is placed

E. Promptly repair vapor barrier damaged during placement of concrete reinforcing. Repair with vapor barrier material; lap over damaged areas minimum 6 inches and seal watertight

3.4 REINFORCING STEEL

A. Accurately position reinforcing steel on supports, spacers, hangers, or other reinforcing steel at maximum intervals of 4 feet on center

B. Secure with wire ties or suitable clips. Tie 50 percent of all reinforcement and reinforcement at intersections for wall and floor construction

C. Except at contact splices, minimum clear distances between bars, the greater of:
   1. Nominal diam of bars
   2. 1.5 times max size of coarse aggregate
   3. 3 inch in other locations

D. Where reinforcement is placed in 2 layers, place bars in upper layer directly above bars in lower layer

E. Do not install reinforcement for beams and slabs which are supported by concrete caissons until after the concrete for the caissons has been placed

F. Do not use brick, plywood or other porous material to support footing steel off the ground. Small precast concrete "adobe" blocks that provide minimum clearances are acceptable.
   1. "adobe" blocks shall be created with concrete having equal or greater 28 day compressive strength

G. Splices:
   1. As specified or indicated on the Drawings
   2. Do not weld or tack weld reinforcing steel except where specifically indicated on Drawings
   3. Remove and replace steel upon which any unauthorized welding has been performed
   4. When splicing bars in tie beams subject to tensile loading, splice no more than half the bars within a length of 40 bar diam and hook each spliced bar end 180 degrees

3.5 EMBEDMENTS

A. Accurately position and securely anchor in forms, anchor rods, steel shapes, conduit, sleeves, masonry anchorages, and other materials to be embedded in concrete
   1. Place anchor rods utilizing a template to ensure spacing and plumb-ness

B. Electrical Conduits:
   1. Install between layers of steel in walls and slabs with steel in both faces
   2. Install under reinforcing steel in slabs with only 1 layer of steel

C. Anchor rods:
   1. Unless installed in pipe sleeves, provide sufficient threads on anchor rods to permit a nut on the concrete side of the form or template
   2. Install a second nut on the other side of the form or template
   3. Adjust the nuts to hold the bolt rigidly in the proper position

D. Clean embedments before installation, ensure any galvanized coatings are complete and firmly bonded to the underlying steel

E. Clean concrete spatter and other foreign substances from surfaces not in contact with concrete

3.6 TRANSPORTING MIXED CONCRETE

A. Transporting of mixed concrete shall conform to ACI 305R

B. Do not exceed manufacturer's guaranteed capacity of truck agitators. Maintain the mixed concrete in a thoroughly mixed and uniform mass during hauling

C. Do not incorporate additional mixing water into the concrete during hauling or after arrival at the delivery point.

D. Provide delivery ticket and comply with delivery requirements of this section

3.7 PLACING CONCRETE

A. Place concrete in accordance with ACI 301

B. Notify General Contractor not less than 24 hrs in advance of the times and places at which concrete shall be placed

C. Predetermine limits at each placement and place all concrete within those limits in one continuous operation

D. Rigidly secure forms, reinforcing steel, embedment, and anchor rods in proper position

E. Remove all mud, water, ice, snow, frozen material, and debris from space to be occupied by concrete

F. Clean surfaces encrusted with dried concrete from previous concrete operations

G. Convey to the point of final deposit by methods which will prevent separation or loss of ingredients

H. Place concrete in final position without being moved laterally more than 5 feet

I. Place concrete in approximately horizontal layers of proper depth for proper compaction, not more than 2 feet

J. Place subsequent layer while the preceding layer is still plastic

K. Place and compact concrete in wall or column forms before placing any reinforcing steel in the system to be supported by the walls and columns

L. Top finish concrete when thoroughly settled

M. Remove all laitance, debris, and surplus water from the tops of the forms by screeding, scraping, or other effective means

N. Overfill the forms for walls whose tops will be exposed to the weather and screed off the excess after the concrete has settled

O. Provide vertical construction joints as required to comply with these requirements

P. Limit portions of columns and walls poured monolithically with floor or roof slabs to 6 feet of vertical height

Q. Allow concrete in walls and columns to settle at least 2 hours before concrete is placed in structural systems to be supported by the walls and columns

R. Carefully deposit concrete for piers and caissons to avoid contact with forms, reinforcing, and earth sides until completion of the drop:
   1. Take necessary precautions to prevent earth or other material from falling into excavations and to prevent dislocation of reinforcing during concreting
   2. Place concrete continuously to the top at a rate of not less than 2 feet per hour
   3. Provide cylindrical steel or fiber forms above grade

3.8 BONDING TO HARDENED CONCRETE

A. Place new concrete on rough, clean, damp faces of existing concrete

B. Remove surface mortar to expose aggregate to 1/4" inch amplitude

C. Clean hardened concrete of all foreign substances, including curing compound, washed with clean water, and keep saturated for 24 hrs preceding placement of fresh concrete

D. Apply epoxy bonding agent for bonding to hardened concrete

3.9 COMPACTION

A. Thoroughly compact concrete during and immediately after placement

B. Work concrete around all reinforcements and embedments and into the corners of the forms

C. Use mechanical vibrators which will maintain 9,000 cycles per minutes when immersed in the concrete, 1-1/2 hp motor minimum

3.10 COLD WEATHER CONCRETING

A. Conform to ACI 306/306R, except as modified herein

B. Minimum concrete temp at the time of mixing:

Outdoor Temp at Placement (in shade)	Concrete Temp at Mixing
Below 30 degrees F	70 degrees F
Between 30 degrees F and 45 degrees F	60 degrees F
Above 45 degrees F	45 degrees F

C. Do not place heated concrete which is warmer than 80 degrees F

D. If freezing temperatures are expected during curing, maintain the concrete temperature at or above 50 degrees F for 5 days or 70 degrees F for 3 days with forms in place

E. Do not allow concrete to cool suddenly

3.11 HOT WEATHER CONCRETING

A. Conform to ACI 305/305R, except as modified herein

B. At air temp of 90 degrees F and above keep concrete as cool as possible during placement and curing

C. Do not allow concrete temperature to exceed 70 degrees F at placement
   1. Utilize cold water for mixing water if necessary, do not use ice.

D. Prevent plastic shrinkage cracking due to rapid evaporation of moisture

E. Do not place concrete when the actual or anticipated evaporation rate equals or exceeds 0.2 lbs per sq ft per hr as determined from ACI 305, Fig 2.1.4

3.12 EXPANSION AND CONTRACTION JOINTS

A. Contraction joints:
   1. Provide as designated by Engineer
   2. Seal accessible edges

B. Expansion material:
   1. Provide as indicated on Drawings
   2. Firmly bond to previously poured joint. Face with a suitable adhesive
   3. Place new concrete directly against joint filler
   4. Seal accessible edges

3.13 CURING AND PROTECTION

A. Protect concrete from moisture loss at relatively constant temperature for at least 7 days after placement except that the time period for curing by saturation for concrete being protected from low temperature shall be 1 day less than the duration of high temperature protection

B. Cure concrete by methods which will keep concrete surfaces adequately wet during curing, in accordance with ACI 308

C. Maintain rate of temperature change less than 5 degrees F in any one (1) hour period

D. Water curing:
   1. Begin water saturation as quickly as possible after initial set
   2. Regulate water application to provide complete surface coverage with minimum runoff
   3. Interrupt the application of water to walls for grout cleaning only over the area being cleaned at the time and do not permit the surface to become dry during such an interruption

E. Membrane curing:
   1. Membrane curing compound may be used in lieu of water curing on concrete which will not be covered later with mortar or concrete
   2. Spray apply membrane curing compound at not more than:
      a. General use: 300 sf per gal recommended
   3. Cover unformed surfaces within 30 minutes of final finishing
   4. If forms are removed before the end of the curing period, immediately apply curing compound to the formed surface before they dry out
   5. Protect curing compound against abrasion during the curing period

F. Film curing:
   1. Polyethylene sheeting may be used in lieu of water curing on concrete which will be covered or hidden from view
   2. Begin film curing as quickly after initial set of the concrete as possible
   3. Completely cover the surfaces with polyethylene sheeting
   4. Overlap the sheeting edges for sealing and anchorage
   5. Seal joints between sheets
   6. Promptly repair tears, holes, and other damage
   7. Anchor covering continuously at edges and on the surfaces as required to prevent billowing

3.14 DEFECTIVE CONCRETE

A. Defective Concrete: 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. Repair defects in formed concrete surfaces within 24 hours of removing forms

D. Replace defective concrete within 48 hrs

E. Cut out and remove to sound concrete honeycombed or otherwise defective concrete

F. Cut edges square to avoid feathering

G. Comply with Chapter 9, ACI 301

H. Perform repair work so as not to interfere with thorough curing of adjacent concrete

I. Adequately cure repair work

3.15 FINISHING FORMED SURFACES

A. Remove fins and other surface projections from all formed surfaces except exterior surfaces that will be in contact with earth backfill and are not specified to be dampproofed

B. Use a power grinder, if necessary, to remove projections and provide a flush surface

C. Remove fins and fill tie hole [on surfaces exposed to view]:
   1. Clean, dry and fill tie holes with non-shrink grout
   2. Finish flush to match the texture of adjacent concrete

D. Grout cleaning under provisions of Chapter 10, ACI 301:

1. Grout clean surfaces exposed to view to produce a smooth uniform surface free of marks, voids, surface glaze and cement dust
2. Use nonshrink grout mix with bonding agent. Dampen surface and apply with cork or rubber float

3.16 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed in accordance with ACI 301 under provisions of Section 01400

B. The General Contractor shall pay for all field and compressive strength tests to determine compliance of concrete materials in accordance with the specifications except as indicated otherwise under provisions of Section 01400

C. Field Control Test:
1. Tests by ACI certified technician
2. Make tests in presence of Engineer
3. Provide all equipment, supplies, and the services of one or more employees, as required
4. The test frequencies specified are minimum. Additional tests may be performed as required by the job conditions

D. Slump: Test a sample from each truck load in accordance with ASTM C143 if requested by Engineer and when making test cylinders

E. Air Content: Test a sample from each truck load if requested by Engineer and when making test cylinders

F. Compression Tests:
1. Make one set of 6 cylinders each day when up to 25cu yds have been placed
2. Make one additional set of 6 cylinders for each additional 25cu yds or each major pour placed in one day
3. Test two cylinders in each set at 7 days
4. Test one cylinder in each set at 14 days
5. Test two cylinders in each set at 28 days
6. The other one cylinder is to be used as directed by Engineer at any time
7. Engineer will evaluate in accordance with ACI 214 and 318
8. Make, cure, store, and deliver cylinders in accordance with ASTM C31
9. Test in accordance with ASTM C39
10. Mark or tag each set of test cylinders with the date and time of day the cylinders were cast, the location in the work where the concrete represented by the cylinders was placed, the delivery truck or batch number, the air content, and the slump

a. Test cylinders shall cured on site in similar conditions as the work represented by the cylinders

G. Storage Facilities for Concrete Test Cylinders:
   1. Including water necessary, a specially prepared box with high-low thermometer and thermostatically controlled heating devices in accordance with ASTM C31

H. Failure of Test Cylinder Results:
   1. Upon failure of 28-day test cylinder results, the Engineer shall obtain and test at least three 4-inch diameter cored samples from area in question
   2. Concrete will be considered adequate if average of three core tests is at least 85 percent of, and if no single core is less than 75 percent of, the specified 28-day strength
   3. In the event an area is found to be structurally unsound, the Engineer may order removal and replacement of concrete as required. Fill all core holes as specified for repairing defective concrete

END OF SECTION

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SECTION 03600

GROUT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Grouting of column and equipment baseplates

B. Grouting of anchors and dowels into existing concrete

C. Other grouting specified or indicated on Drawings

1.2 RELATED SECTIONS

A. Section 01330—Shop Drawings, Product Data, and Samples

B. Section 03000—Concrete

C. Section 05501—Anchor Bolts and Expansion Anchors

1.3 REFERENCES

A. ASTM C109—Test Method for Compressive Strength of Hydraulic Cement Mortar

B. ASTM C157—Test Method for Length Change of Hardened Hydraulic Cement Mortar and Concrete

C. ASTM C191—Time of Setting of Hydraulic Cement by Vicat Needle

1.4 SUBMITTALS

A. Submit under provisions of Section 01330

B. Product Data: Provide manufacturer's catalog sheet for material indicating test data and physical properties

1.5 QUALITY ASSURANCE

A. Conform to applicable industry standard, Corps of Engineers, Specification CRD-C 621—Specification for non-shrink grout

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Non-Shrink, Non-Metallic Grout:
   1. Five Star Products – Five Star Grout
   2. Master Builders—Masterflow 928
   3. W.R. Meadows—Sealtight 588
   4. Sika—SikaGrout 212
   5. Or equal

B. Epoxy/Grout Adhesive:
   1. Hilti Hit HY-200
   2. Or approved alternate

C. Latex Bonding Agent:
   1. Speeco—B20 Liquid Latex
   2. Euclid—Flexbond
   3. W.R. Meadows—Intralok Bonding Agent

2.2 MATERIALS

A. Non-Shrink, Non-Metallic Grout: Factory premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents, capable of developing minimum compressive strength of 4,000 psi in one day and 8,000 psi in 7 days

B. Epoxy Grout: Three Component Epoxy Resin System:
   1. Two liquid epoxy components
   2. One inert aggregate filtered component
   3. Each component furnished in separate package for mixing at job site

C. Water: Clean and free from deleterious substances

D. Latex Bonding Agent: Acrylic liquid compound readily mixable as an admixture to grout

PART 3 EXECUTION

3.1 PREPARATION

A. Non-Shrink, Non-Metallic Grout:
   1. Clean concrete surface to receive grout
   2. Saturate concrete with water for 24 hrs prior to grouting and remove excess water just prior to placing grout
   3. Cold weather conditions:

a. Warm concrete, substrate and base plate to 40 degrees F, or above; store grout in warm area
b. Follow manufacturer's recommendations for cold weather application

4. Hot weather conditions:
   a. Use cold mixing water and cool base plate if possible; store grout in cool area
   b. Follow manufacturer's recommendations for hot weather application
5. Apply to clean, sound surface
6. Apply latex bonding agent to hardened concrete, mix-in-grout, or as directed by Engineer.

B. Epoxy Grout: Apply only to clean, dry, sound surface

3.2 APPLICATION

A. Non-Shrink, Non-Metallic Grout:
1. Mix in a mechanical mixer
2. Use no more water than necessary to produce flowable grout
3. Provide air vents where necessary to eliminate air pockets
4. Place in accordance with manufacturer's instructions
5. Completely fill all spaces and cavities below the top of baseplates
6. Provide forms where baseplates and bedplates do not confine grout
7. Where exposed to view finish grout edges smooth
8. Protect against rapid moisture loss by immediately covering with wet fabric and polyethylene sheets or curing compound
9. Wet cure grout for 3 days, minimum
10. Maintain the temperature at a minimum of 40 degrees F until grout reaches 3,000 psi compressive strength
11. After placement of grout, eliminate vibration until initial set has occurred.

B. Epoxy Grout:
1. Mix and place in accordance with manufacturer's instructions
2. Completely fill all cavities and spaces around dowels and anchors without voids
3. Obtain manufacturer's field technical assistance as required.

3.3 SCHEDULE

A. Non-Shrink, Non-Metallic Grout: General Use:
1. Grouting of column and equipment baseplates

B. Epoxy Grout:
1. Grouting of dowels and anchor bolts into hardened concrete

END OF SECTION

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SECTION 05501

ANCHOR BOLTS AND EXPANSION ANCHORS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Equipment anchor bolts

B. Structural anchor bolts

C. Expansion anchors

1.2 RELATED SECTIONS

A. Section 01330—Shop Drawings, Product Data, and Samples

B. Section 01600—Common Product Requirements

C. Section 03000—Concrete

D. Section 03600—Grout

E. Divisions 11 and 13—Individual Equipment Sections where Anchor Bolts are required

1.3 REFERENCES

A. ANSI B18.16.3—Nuts and Hex Flange Nuts, Dimensional Requirements for Prevailing-Torque-Type Steel Metric Hex

B. ANSI B18.21.1—Lock Washers

C. ANSI B18.22.1—Plain Washers

D. ANSI B18.23.1—Beveled Washers

E. ASTM A53—Pipe, Steel, Black and Hot-Dipped Zinc Coated (Galvanized) Welded and Seamless for Ordinary Users

F. ASTM A123—Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

G. ASTM A193—Alloy Steel and Stainless Steel Bolting Materials for High Temperature Service

H. ASTM A780—Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

I. ASTM F593—Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs

1.4 SUBMITTALS

A. Submit under provisions of Section 01330

B. Shop Drawings: Provide sizes and dimensions. Indicate or identify location where anchor bolts are to be used

C. Product Data: Provide sufficient information to verify compliance with specifications

1.5 QUALITY ASSURANCE

A. Unless otherwise specified or shown on the Drawings, anchor bolts for equipment provided under this Contract shall be designed and sized by the responsible equipment manufacturer as specified in Section 01600

B. Unless otherwise specified, the General Contractor shall provide and install all anchor bolts for this Contract in accordance with the responsible manufacturer's design recommendations or as shown on the Drawings

C. Anchor rod templates for equipment shall be provided by the responsible manufacturer

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products and materials under provisions of Section 01600

B. Deliver anchor bolts and templates in time to permit setting when structural concrete is placed

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Expansion Anchors:
   1. Hilti - Kwik Bolt TZ, Carbon steel or Stainless Steel 304
   2. Or approved stainless steel alternate

2.2 MATERIALS

A. Bolts or threaded rods:
   1. Carbon Steel: ASTM F1554, Grade 36
   2. Stainless Steel: 304 or 316

B. Nuts:
   1. Same material as bolts or anchors

C. Washers:
   1. Same material as bolts or anchors

D. Expansion anchors:
   1. General use: Carbon Steel
   2. Submerged service: Stainless Steel 304
   3. In hardened concrete and grouted masonry: Carbon Steel

2.3 FABRICATION

A. Rods: Carbon Steel ASTM F1554, size as indicated on Design Drawings.

B. Anchor Bolts—3/4 inch minimum diameter except as indicated by equipment manufacturer or on Design Drawings:
   1. Straight bolt with heavy hex head

C. Expansion Anchors: 3/4 inch maximum diameter except as indicated on Design Drawings, length as required for proper embedment where required

PART 3 EXECUTION

3.1 INSPECTION

A. Verify that holes for anchor bolts in forms and templates match applicable Shop Drawings prior to casting concrete.

3.2 INSTALLATION

A. Anchor bolts—General use:
   1. Provide for structural steel framing and anchoring equipment as indicated on Design Drawings.
   2. Provide 3 nuts for each anchor rod for which a lock nut (double nut) is indicated, 2 for others.
   3. Where installed in cast-in-place concrete, install a nut on the concrete side of the form or supporting template. This nut shall be removed when the template is removed.

B. Expansion anchors:
   1. General use: Where required for pipe supports, anchoring wall panels and miscellaneous anchor requirements
   2. Do not use cinch anchors
   3. Install in conformity with the manufacturer's instructions
   4. Minimum embedment: per manufacturer's recommendations or Design Drawings, whichever is greater.
   5. Minimum distance between expansion anchor centerline any edge or exterior corner of concrete: 4-1/2 rod diameters.

3.3 SCHEDULE

A. Anchor bolts:
   1. In all Cast-In-Place applications.

B. Expansion anchors:
   1. In hardened concrete and grouted masonry: Type “A”. Locate as indicated on Design Drawings.

END OF SECTION

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TETRA TECH	**Painting** **Technical Specification**	**SPECIFICATION NUMBER: 09900** **PROJECT NUMBER: 117-7502016-L09** **PROJECT NAME: Weir Dewatering Treatment**

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SECTION 09900

PAINTING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Surface preparation and application of primer and finish coatings for all new surfaces and existing surfaces as scheduled

1.2 RELATED SECTIONS

A. Section 01330—Shop Drawings, Product Data, Samples

B. Section 01400—Quality Control

C. Section 01600—Common Product Requirements

D. Section 01730—Operation and Maintenance Data

E. Division 11 – Equipment Specifications

F. Division 15 – Mechanical Specifications

1.3 REFERENCES

A. ASTM D16—Definitions of Terms Relating to Paint, Varnish, Lacquer, and Related Products

B. ASTM D2016—Test Method for Moisture Content of Wood

C. AWWA (American Water Works Association)—C204—Chlorinated Rubber-Alkyd Paint Systems for the Exterior of Above Ground Steel Water Piping

D. AWWA (American Water Works Association)—D102—Painting Steel Water Storage Tanks

E. NACE (National Association of Corrosion Engineers)—Industrial Maintenance Painting

F. NPCA (National Paint and Coatings Association)—Guide to U.S. Government Paint Specifications

G. PDCA (Painting and Decorating Contractors of America)—Painting—Architectural Specifications Manual

H. SSPC (Steel Structures Painting Council)—Steel Structures Painting Manual

1.4 DEFINITIONS

A. Conform to ASTM D16 for interpretation of terms used in this Section.

1.5 SUBMITTALS

A. Submit under provisions of Section 01330

B. Product data: Provide data on all finishing products. Clearly identify paint type and intended use as outlined by schedules at the end of this section. Include material safety data sheets.

C. Color samples:
   1. Furnish color chips for color selection by Engineer.
   2. General Contractor will prepare color schedule after resubmittals. Supplier will provide colors in accordance with Schedule.

D. Field samples: Submit two samples, 4 by 4 inch in size illustrating selected colors and textures for each color selected.

E. Manufacturer's instructions: Indicate special surface preparation procedures and substrate conditions requiring special attention.

F. Maintenance data: Provide in Materials and Finishes Manual under provisions of Section 01730

G. Painting Schedule—to accomplish final color selection by Engineer, prepare painting schedule identifying:
   1. All surfaces to be painted
   2. Surface preparation used
   3. Type of primer coating, film thickness, shop or field applied
   4. Type of finish coating, film thickness, shop or field applied

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

B. Applicator: Company specializing in performing the work of this section with minimum 3 years documented experience and approved by manufacturer for surface preparation and application of similar coating systems.

1.7 REGULATORY REQUIREMENTS

A. Conform to applicable code for flame and smoke rating requirements for finishes.

B. Comply with all health and fire regulations of agencies having jurisdiction for storage of materials.

C. Comply with current Nevada state requirements for air quality control permit and standards for sandblasting.

D. Comply with current Nevada state requirements for Volatile Organic Compounds (VOC's).

1.8 FIELD SAMPLES

A. Provide field sample of paint under provisions of Section 01400.

B. Provide field sample panel, 3 feet long by 3 feet wide, illustrating coating color, texture, and finish.

C. Locate where directed.

D. Accepted sample may remain as of the Work.

1.9 PRE-APPLICATION CONFERENCE

A. Coating manufacturer or manufacturer's representative will conduct a meeting to establish specific surface preparation procedures acceptable to Engineer and application and protection procedures of finished surfaces.

B. SUPPLIER will coordinate meeting 7 days prior to the start of work in this section. Inspection and testing procedures will be established under provisions of Section 01400.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability. Maintain labels legible and intact.

B. Container label to include manufacturer's name, type of coating, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, Federal specification number, instructions for mixing and reducing and VOC content.

C. Store only acceptable project materials on project site.

D. Store coating materials at minimum ambient temperature of 45 degrees F and a maximum of 90 degrees F, in ventilated area, and as required by manufacturer's instructions and acceptable to Engineer.

E. Restrict storage area to paint materials and related equipment.

1.11 ENVIRONMENTAL REQUIREMENTS

A. Comply with manufacturer's instructions as to environmental conditions under which coatings and coating systems can be applied.

B. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the coating manufacturer's instructions and acceptable to Engineer.

C. Do not apply exterior coatings during rain or snow, or when relative humidity is outside the humidity ranges required by the coating manufacturer's instructions and acceptable to Engineer.

D. Do not apply finish in areas where dust is being generated.

E. Minimum application temperatures for latex paints: 45 degrees F for interiors; 50 degrees F for exterior; unless permitted otherwise by manufacturer's instructions and acceptable to Engineer.

F. Relative humidity: 85 percent maximum.

G. Provide lighting level of 80 foot candles measured mid-height at substrate surface

1.12 EXTRA MATERIALS

A. Provide 1 gallon of each color, type, and surface texture used for the work to Engineer.

B. Label each container with color, type, texture, and locations in addition to the manufacturer's label.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Rust inhibitive general purpose primer:
   1. Tnemec—Series 10-99 Primer
   2. Or approved equal

B. Rust inhibitive zinc-rich primer:
   1. Tnemec—Hydro Zinc 91-H2O or 94-H2O
   2. Or approved equal

C. Coal tar (one component):
   1. Tnemec—Series 46-465 HB Tnemecol
   2. Or approved equal

D. Concrete filler and surfacer (potable water):
   1. Tnemec—Series 218 Mortar Clad
   2. Or approved equal

E. Coal tar epoxy:
   1. Tnemec—Series 46H-413 Hi-Build Tneme-Tar
   2. Or approved equal

F. Field catalyzed epoxy primer and finish coatings (tank interior):
   1. Tnemec—Series 61
   2. Or approved equal

G. Epoxy pipe interior coatings:
   1. Tnemec—Series 431 Perma Shield PL
   2. Or approved equal

H. Field catalyzed epoxy primer and finish coatings (other non-wetted steel process equipment and drives):
   1. Tnemec—Series N140
   2. Or approved equal

I. Moisture cured polyurethane (steel and concrete surfaces):
   1. Tnemec—Series 446 Perma-Shield MCU
   2. Or approved equal

J. Polyurethane finish coatings (tank exterior):
   1. Tnemec—Series 73U Endura-Shield III
   2. Or approved equal

K. Field catalyzed epoxy primer coatings:
   1. Tnemec—Series N69 Hi-Build Epoxoline II
   2. Or approved equal

L. Galvanized surface repair where directed by the Engineer:
   1. Tnemec—Series 90-97 Tneme-Zinc
   2. ZRC—Cold Galvanizing Compound
   3. Brite Products—Brite Zinc Galvanizing Compound
   4. Or approved equal

M. Special purpose primer where directed by the Engineer:
   1. Tnemec—Series 1 Omnithane
   2. Or approved equal

N. Aluminum heat resistant paint:
   1. Tnemec—Series 38-1261 Aluminum
   2. Or approved equal

O. Aluminum paint:
   1. Tnemec—Series 43-36 Chrome Aluminum
   2. Or approved equal

P. Latex emulsion:
   1. Acrylic containing at least 50 percent by weight non-volatile solids
   2. Tnemec—Series 6 Tneme-Cryl
   3. Or approved equal

2.2 MATERIALS

A. Use product of single manufacturer for coating systems for each type of surface.

B. Use paint compatible with shop coating or primer for field coating of shop painted or primed surfaces.

C. Use only mercury-free, fume-proof paint for intermediate and finish coats. Paint must be suitable for atmosphere containing hydrogen sulfide.

D. Use only lead-free paint or paint that does not cause discoloration in treatment plant atmosphere.

E. Coatings: Ready mixed, except field catalyzed coatings. Process pigments to a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating; good flow and brushing properties; capable of drying or curing free of streaks or sags.

F. Accessory materials: Linseed oil, shellac, turpentine, paint thinners, and other materials not specifically indicated but required to achieve the finishes, specified or commercial quality.

G. Patching materials: Latex filler.

H. Fastener head cover materials: Latex filler.

2.3 FINISHES

A. Refer to schedule at end of section for surface finish and color schedule.

B. Use paint by same manufacturer for successive field coats.

C. Field coats to be compatible with shop applied undercoats.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify site conditions.

B. Verify that surfaces are ready to receive work as instructed by the product manufacturer.

C. Examine surfaces scheduled to be finished that will adversely affect execution, permanence, or quality of work and which will not allow preparatory work outlined in preparation of surfaces. Report any condition that may potentially affect proper application prior to commencement of work.

D. Do not proceed with surface preparation or coating application until conditions are suitable.

E. Test shop applied primer for compatibility with subsequent cover materials.

F. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces are below the following maximums:
   1. Concrete: 8 percent
   2. Concrete floors: 8 percent

3.2 SANDBLASTING PROCEDURES

A. Steel: Structural, pipe, angles, beams, equipment, wall plates, pipe hangers, rods, pipe supports, stairs, platforms, handrails, plus steel accessories:
   1. Non-submerged: SSPC-SP6
   2. Submerged or partially submerged (all interior tank surfaces): SSPC-SP10
   3. High temp surfaces to 1,200F: SSPC-SP10

B. Ductile iron, cast iron: Pipe, equipment, fittings, plus miscellaneous items:
   1. Non-submerged: SSPC-SP6
   2. Submerged or partially submerged (all interior tank surfaces): SSPC-SP10

C. Mill coated steel pipe:
   1. Exterior non-submerged: SSPC-SP6
   2. Exterior submerged or partially submerged: SSPC-SP10

D. Concrete: Floor, wall, channels and troughs:
   1. Submerged or partially submerged: SSPC-SP13

E. Profile of sandblasted surface: 2 mils.

F. Do not allow surfaces to become wet after blasting and before painting.

G. Apply primer same day as blasting.

H. Air free of water and oil.

I. Confine sandblast sand to area being prepared.

J. Protect nameplates, valve stems, rotating equipment, motors and other damageable items.

K. Do not reuse sand.

L. Plug pipe, holes, or openings before sandblasting keep covered until sand is removed.

3.3 PREPARATION OF SURFACES

A. Correct defects and clean surfaces which affect work of this section. Remove existing coatings that exhibit loose surface defects.

B. Seal with shellac and seal marks which may bleed through surface finishes

C. Impervious surfaces:
   1. Remove mildew by scrubbing with solution of tri-sodium phosphate and bleach
   2. Rinse with clean water and allow surface to dry

D. Insulated coverings: Remove dirt, grease, and oil from canvas and cotton.

E. Concrete floors:
   1. Remove contamination, acid etch, and rinse floors with clear water
   2. Verify required acid-alkali balance is achieved
   3. Allow to dry

F. Galvanized surfaces:
   1. SSPC-SP1
   2. Spot prime defects after repair

G. Concrete surfaces scheduled to receive paint finish:
   1. Remove dirt, loose mortar, scale, salt or alkali powder, and other foreign matter
   2. Remove oil and grease with a solution of tri-sodium phosphate; rinse well and allow to dry
   3. Remove stains caused by weathering or corroding metals with a solution of sodium metasilicate after thoroughly wetting with water
   4. Allow to dry

H. Exterior uncoated steel and iron surfaces:
   1. Remove grease, mill scale, weld splatter, dirt, and rust
   2. Where heavy coatings of scale are evident, remove by wire brushing or sandblasting where directed by Engineer; clean by washing with solvent
   3. Apply a treatment of phosphoric acid solution, ensuring weld joints, bolts, and nuts are similarly cleaned
   4. Spot prime paint after repairs

I. Shop primed steel surfaces:
   1. Sand and scrape to remove loose primer and rust by power tool, wire brushing or sandblasting where directed by Engineer
   2. Feather edges to make touch-up patches inconspicuous
   3. Clean surfaces with solvent
   4. Prime bare steel surfaces.

3.4 MIXING AND TINTING

A. Deliver paints and enamels ready-mixed to job site.

B. Mix only in mixing pails, suitably sized, non-ferrous or oxide metal pans.

C. Use tinting colors recommended by manufacturer for specific type of finish.

D. Do not add any adulterants or unauthorized thinners.

E. Thoroughly mix each time paint is withdrawn from container.

F. Keep containers closed tightly except while paint is withdrawn.

G. Thinning only permitted to obtain recommended coverage at lower application temperatures.

3.5 APPLICATION

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

B. Do not apply initial coating until moisture content of surface is within moisture limitations recommended by manufacturer's instructions and acceptable to Engineer.

C. Do not apply finishes to surfaces that are not dry. Comply with recommendation of manufacturer for drying time between succeeding coats.

D. Apply each coat to uniform finish free of visible brush marks, streaks, laps and missed areas.

E. Vary the color of successive coats slightly. Apply each coat of paint slightly darker than preceding coat unless otherwise approved.

F. Apply coating with suitable brushes, rollers, or spraying equipment:
   1. Do not exceed rate of application recommended by manufacturer for the type of surface involved
   2. Keep brushes, rollers, and spraying equipment clean, dry, free from contaminants and suitable for the finish required

G. Sand lightly between coats to remove defects to achieve smooth uniform finish acceptable to Engineer.

H. Vacuum clean surfaces free of loose particles. Use tack cloth just prior to applying next coat.

I. Allow applied coat to dry before next coat is applied.

J. Provide tie coats where recommended by manufacturer's instructions and acceptable to Engineer.

K. Do not apply additional coats until completed coat has been inspected by the Engineer:
   1. Only inspected coats of paint will be considered in determining number of coats applied

L. Make edges of paint adjoining other materials or colors clean and sharp with no overlapping.

M. Rate of application:
   1. Coverage not greater than value recommended by manufacturer's instructions
   2. Use of paint thinner not to be used as means of extending coverage of paint

N. Where clear finishes are required, tint fillers to match wood. Work fillers into the grain before set. Wipe excess from surfaces.

O. Prime concealed surfaces of interior and exterior woodwork with primer paint

P. Prime concealed surfaces of interior woodwork scheduled to receive stain or varnish finish with gloss varnish reduced 25 percent with mineral spirits.

Q. Finish coat equipment supplied by Engineer or other Sub Contractors within recommended period of time with compatible coating.

3.6 CLEANING

A. Clean work prior to commencing application

B. Collect waste material which may constitute a fire hazard, place in closed metal containers and remove daily from site.

C. Remove spilled or splattered paint from all finished surfaces.

D. Do not mar or scratch surface finish of items being cleaned.

3.7 PROTECTION OF FINISHED WORK

A. Use drop cloths, masking tape and other measures to protect all surfaces from accidental spraying, spattering, or spilling of paint.

B. Prepare surface and re-coat surfaces damaged during delivery and installation or by construction activity.

C. Repair all damage caused by coating other items of work:
   1. Immediately remove paint deposited on surfaces not to be coated

D. Protect galvanized steel finishes and repair damaged surfaces as follows:
   1. Power tool clean foreign matter, rust, slag residue, weld splatter from both damaged and contiguous undamaged area
   2. Clean with phosphoric acid base
   3. Brush apply two coats of cold galvanizing compound and overlap at least two inches onto contiguous undamaged area

3.8 SURFACES NOT TO BE PAINTED

A. Except as otherwise required or directed, do not paint the following surfaces:
   1. Exposed surfaces of aluminum
   2. Polished or finished stainless steels. Unfinished or dull stainless steel shall be painted
   3. Nickel or chromium
   4. Galvanized surfaces, except piping, conduit, duct work, and other items specifically noted
   5. Rubber and plastics that flex
   6. Copper instrument or pressure gage tubing
   7. Piping concealed in inaccessible plumbing chases and above suspended ceilings
   8. Face brick and exterior concrete
   9. Surfaces specified to be factory finished

3.9 PIPING AND ACCESSORIES

A. Coat all exposed piping and piping in accessible places in accordance with the color schedule to be selected.

B. Coat any piping not scheduled to be color-coded to match adjacent wall or ceiling surface, include appropriate service identification and flow direction arrows.

C. Locate lettering and flow direction arrows near equipment served, adjacent to valves, both sides of walls and floors where pipe passes through, at each branch or tee and at intervals of approximately 25 feet in straight runs of pipe acceptable to Engineer.

D. Provide metal tags instead of lettering for all pipes with outside diameter or pipe covering diameter 5/8 inch or smaller. Tags are to be of stainless steel or aluminum with identifying lettering stamped in and fastened to pipe with suitable chains.

3.10 FIELD QUALITY CONTROL

A. Comply with inspection and film thickness testing requirements of this section, SSPC-Volume 1, Chapter 6 and SSPC-PA 2. Provide under provisions of Section 01400

B. General inspection sequence as follows:
   1. Pre-surface preparation observation
   2. Measurement of ambient conditions
   3. Evaluation of compressor (air cleanliness) and surface preparation equipment
   4. Determination of surface preparation cleanliness and profile
   5. Review of application equipment
   6. Witnessing of coating mixing
   7. Observing coating application
   8. Determination of wet film thickness (non-metallic substrates)

9. Determination of dry film thickness (metallic or non-ferrous metal substrates)
10. Pinhole and holiday testing of shop coatings as required
11. Adhesion testing as required
12. Evaluating cure

C. Wet film thickness (WFT) testing:
1. Standard "notch" configuration or circular dial gages
2. Use for concrete, wood or other non-metallic substrates
3. Determine dry film thickness per the following:
4. $$WFT = \frac{\text{specified dry film thickness}}{\%\ \text{solids by volume}}$$
5. Decrease percent solids by volume if coating is thinned per the following:
6. $$WFT = \frac{\text{specified dry film thickness}}{\%\ \text{solids by volume}\left(100\% + \%\ thinner\ added\right)}$$
7. Calibrate gage per manufacturer's instructions acceptable to Engineer

D. Dry film thickness (DFT) testing:
1. Type 1: Magnetic pull-off type gage
2. Type 2: Fixed probe magnetic flux gage with microprocessor
3. Calibrate gage per manufacturer's instructions and SSPC-PA 2 acceptable to Engineer
4. Use eddy current type gage or probe attachment for non-ferrous metal substrates
5. Gage accuracy: ±10 percent

E. Number of measurements and minimum thickness in accordance with SSPC-PA 2:
1. Make five (5) separate spot measurements (average of three readings for each spot measurement) spaced evenly over each 100 square feet (9.3 square meters) of area to be measured
2. The average of five spot measurements for each such 100 square foot area shall not be less than the specified thickness
3. No single spot measurement in any 100 square foot area shall be less than 80 percent of the specified thickness
4. Any one of three readings which are averaged to produce each spot measurement may under-run by a greater amount
5. The five spot measurements shall be made for each 100 square feet of area as follows:
    a. For structures not exceeding 300 square feet in area, each 100 square foot area shall be measured
    b. For structures not exceeding 1,000 square feet in area, three 100 square foot areas shall be randomly selected and measured
    c. For structures exceeding 1,000 square feet in area, the first 1,000 square feet shall be measured as stated above and for each additional 1,000 square feet of area or increment thereof, one 100 square foot area shall be randomly selected and measured

6. If the dry film thickness for any 100 square foot area is not in compliance with the requirements above, then each 100 square foot area shall be measured
7. General Contractor shall reimburse Engineer for additional time required to inspect each 100 square foot area in addition to the above spot measurement requirements. An additional coat may be applied in lieu of additional testing

F. Other size areas or number of spot measurements may be adjusted as appropriate for the size and shape of the structure to be measured as determined by Engineer.

3.11 SCHEDULE—STEEL TANK METAL SURFACES

A. All non-submerged surfaces of structural and miscellaneous steel exposed—exterior locations, except those supplied with a factory finish:
   1. Epoxy/urethane coating system:
      a. Primer: One coat epoxy—4 mils
      b. Finish: One coat polyurethane—4 mils
      c. Total dry film thickness: 8 mils
      d. Per AWWA Outside Paint System

B. All submerged, partially submerged or potentially submerged surfaces of structural and miscellaneous steel including galvanized surfaces, cast iron, ductile iron pipe, valves and accessories—exposed interior locations:
   1. Epoxy coating system:
      a. Primer: One coat epoxy based—10 mils
      b. Finish: One coat epoxy based—10 mils
      c. Total dry film thickness: 20 mils
      d. Per AWWA Inside Paint System

3.12 SCHEDULE—METAL SURFACES

A. All non-submerged surfaces of structural and miscellaneous steel exposed inside buildings, including roof joists, roof deck, other galvanized surfaces, doors and frames, steel handrails, pumps, motors, other machines and process equipment:
   1. Primer: One coat catalyzed epoxy—4 mils
   2. Finish: One coat polyurethane—4 mils
   3. Total dry film thickness: 8 mils

B. All non-submerged and exposed interior and exterior surfaces, unless otherwise specified, including valves, cast iron pipe, ductile iron pipe and steel pipe in pump rooms, pipe galleries, and other process piping areas including but not limited to supports, fittings, couplings, flanges, and bolts:
   1. Primer: One coat catalyzed epoxy primer—4 mils
   2. Finish: One coat polyurethane—4 mils
   3. Total dry film thickness: 8 mils

C. All non-submerged and exposed interior and exterior factory finished surfaces of process equipment, unless otherwise specified, including sump pumps, mixers, reuse pumps, motors, machines and other process equipment to match identification color coding system:
   1. Finish: One coat polyurethane—4 mils
   2. Total dry film thickness: 4 mils

D. All submerged or partially submerged and exposed interior and exterior surfaces, unless otherwise specified, including valves, cast iron, and steel pipe in wet wells or basins, including but not limited to weir plates, supports, fittings, flanges, and bolts:
   1. Primer: One coat rust inhibitive zinc-rich shop primer—3 mils
   2. Finish: One coat coal tar epoxy—18 mils
   3. Total dry film thickness: 20 mils minimum

E. All exposed surfaces of electrical conduit inside buildings, including fittings, boxes, supports, and accessories, except banks of conduits in multiple layers hung from ceilings:
   1. Primer: One coat rust inhibitive general purpose shop primer—3 mils
   2. Finish: Two coats semi-gloss alkyd enamel —6 mils
   3. Total dry film thickness: 9 mils

F. All surfaces subject to medium temperatures including engine exhaust piping:
   1. Primer: One coat heat resistant aluminum—1.5 mils
   2. Finish: One coat heat resistant aluminum—1.5 mils
   3. Total dry film thickness: 3 mils

G. Miscellaneous castings, including manhole rings and covers and manhole steps:
   1. Finish: One coat coal tar epoxy—16-20 mils
   2. Total dry film thickness: 16-20 mils

3.13 SCHEDULE—OTHER EXTERIOR SURFACES

A. Steel—Galvanized:
   1. Primer: One coat galvanize primer 3 mils
   2. Finish: Two coats acrylic enamel, semi-gloss 3 mils
   3. Total dry film thickness: 9 mils

B. Steel—Primed:
   1. Primer: Touch-up with primer used
   2. Finish: Two coats acrylic enamel, gloss 3 mils
   3. Total dry film thickness: 9 mils

C. Steel—Galvanized:
   1. Primer: One coat galvanize primer 3 mils
   2. Finish: Two coats acrylic enamel, gloss 3 mils
   3. Total dry film thickness: 9 mils

3.14 SCHEDULE—COLORS

A. Colors to be selected by Engineer from General Contractor provided paint schedule after approved paint submittal

END OF SECTION

SPECIFICATION REVISION INDEX

Revision No.	Revision Date	Issued for	Signatures				
			Prepared By	Reviewed By	Project Engineer	Project Manager	Client
A	11/28/2016	60% Submittal	CMF	JG	JG	STD	
B	1/27/2017	DRAFT 90% Submittal	CMF	JG	JG	STD	
C	2/15/2017	75% Submittal	CMF	JG	JG	STD	

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SECTION 11210

MULTI-MEDIA FILTERS

TABLE 1: SUMMARY OF PROCESS PARAMETERS

Parameter	Units	Value
Average Flowrate	gpm	5,000
Maximum Flowrate	gpm	6,900
No. of Filters	Ea.	3
Average influent TSS concentration	ppm	10
Maximum influent TSS concentration	ppm	40
Target effluent TSS concentration	ppm	5
Maximum pressure drop across filter before backwash	psi	15
Available pressure for backwash	psi	40
Maximum operating pressure	psi	100
Maximum operating temperature	°F	150
Minimum solids removal efficiency *(particles 10 microns and larger)*	%	90
Minimum solids removal efficiency *(particles 5 to 10 microns)*	%	60
Specific Gravity	-	2.0

SECTION 11210

MULTI-MEDIA FILTERS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section describes materials, fabrication, and testing of a complete pre-engineered Multi-Media Filters (MMF) System described herein for the removal of suspended solids from water produced during weir construction dewatering operation. The system shall be complete with down-flow Multi-Media filter vessels, piping, valves, gauges, flow meters, fittings, and instrument and controls including automatic backwash operation control system. An air scouring system to facilitate filter backwash shall also be provided.

B. The system supplied shall capable of treating 6,900 gpm of influent flow at a maximum suspended solids concentration of 40 ppm with all filter vessels online. The system shall be designed such that it will, at minimum, remove 95% all particles greater than 10 micron contained in the influent stream. The effluent shall contain less than 5 ppm TSS.

1.2 RELATED SECTIONS

A. Section 01330—Shop Drawings, Product Data, and Samples

B. Section 01400 – Quality Control

C. Section 01600 – Common Product Requirements

D. Section 01630 – Product Options and Substitutions

E. Section 01730 – Operation and Maintenance Data

F. Section 01810 – Starting of Systems

1.3 COORDINATION

A. The Multi-Media Filter Supplier will be responsible for providing and delivering equipment and appurtenances to the project site as specified herein.

B. The equipment shall be installed by the General Contractor, who will be responsible for off-loading the equipment, providing any temporary storage in accordance with the Supplier's recommendation for storage and installing the equipment in place.

1.4 WORK TO BE INCLUDED

A. The Multi-Media Filter (MMF) Supplier shall be responsible for supplying all system components needed to operate the multi-media filter per the specification, including, but not

limited to, filter vessels and media, interconnecting piping, wiring, and electronic connections, valves, instruments, supports, air scouring blower and all accessories required for a complete and working system. The MMF Supplier shall be responsible for the design, engineering, fabrication, factory testing and delivery of all mechanical components, including vessels, air blower, piping, valves and instrumentation for the filter system. The MMF Supplier shall provide two (2) days of operator training and start-up at the site.

B. Each filter vessel shall consists of two (2) filter cells, and shall come with a piping skid furnished with an influent, an effluent, a rinse/backwash water inlet, a rinse water discharge, a backwash waste discharge and an air scouring inlet connections for the filter vessel, as well as control valves and other instruments and piping components necessary to make the filter vessel fully functional. Any vessel and pipe skid supports and anchoring devices shall be included.

C. A magnetic flowmeter and a modulating flow control valve shall be equipped for each filter vessel so that the incoming flow can be evenly distributed within all three (3) filter vessels operating in parallel. Each filter vessel backwash inlet line shall be equipped with a magnetic flowmeter to assist filter backwash operation.

D. An air scouring system, including a blower, associated valves, pipes and instruments within the pipe skid as mentioned previously, shall be provided to facilitate backwash for all three (3) filter vessels. The air pipe connecting the blower and the filter vessels shall be done by others.

E. The MMF Supplier shall be responsible for the supply and delivery of all media used, including but not limited to anthracite, fine garnet, coarse garnet, and crushed rock to the job site.

F. The MMF System as specified herein shall be comprised of:

1. At least three (3) trains with each train consisting of one (1) filter vessel operating in parallel. Each filter vessel shall consist of two cells with downflow multi-media in each cell. The system shall have adequate capacity to operate at maximum influent flow and total suspended solids loading. System shall be able to treat the average flow of 5,000 gpm when one (1) filter cell is out of service.
2. Associated process and utility piping, wiring and electrical connections, valves, pressure sensors, flow meters, and other accessories for each train which may be necessary for the proper operation of the filtration system.
3. Vent and pressure relief piping and flush water connections.
4. Pre-backwash rinse system piping, valves, and accessories.
5. Backwash system piping, valves, control and accessories. Two (2) magnetic flow meters per train, one for feed water and one for backwash water.
6. Backwash air scouring system piping, valves and accessories.
7. One (1) pressure safety valve per filter cell.

8. PLC Control panel with a NEMA 4X stainless steel enclosure for automatic filter operation control, including programing of the PLC.

9. Filter media and support media for all vessels.

10. One (1) complete set of technical specifications and plans and two (2) sets of operation and maintenance manuals.

11. Training of site operators by certified representative for two (2) days excluding travel time.

G. Work by Others

1. Unloading and staging of equipment

2. Reinforced concrete foundations

3. Setting and final anchoring of equipment to foundations

4. Influent header into the filter vessel pipe skids

5. Effluent header out of the filter vessel pipe skids

6. Rinse/backwash header into the filter vessel pipe skids

7. Rinse/drain header out of the filter vessel pip skids

8. Backwash discharge header out of the filter vessel pip skids

9. Air scouring header from the air blow into the filter vessel pipe skids

10. Electrical power supply.

11. The loading of multi-media into the vessels.

1.5 SUPPLIER'S QUALIFICATIONS

A. The Supplier of the MMF equipment shall have the following minimum qualifications:

1. Have previously designed, engineered and furnished multi-media filter treatment systems within the United States, designed for a minimum of 1,000 gpm per vessel. Systems cited in experience submittals shall have downflow, pressure-type configurations using the same vessel diameter and design, and meeting these specifications.

2. Have furnished at least one (1) similar Multi-Media Filter system currently in use and removing suspended solids from the influent water stream. This system shall be designed to treat at least 1,000 gpm/vessel.

3. Provide three (3) references, with contact information, for systems described above.

1.6 WARRANTY

A. The MMF Supplier shall guarantee all equipment to be free of defects in material and workmanship for a period of 18 months from date of delivery of the equipment or 12 months from the date of final acceptance, whichever is longer.

1.7 MULTI-MEDIA FILTER SUPPLIER SERVICES

A. The MMF Supplier shall inspect all equipment upon delivery to the site and repair or replace damaged equipment. The MMF Supplier shall inform General Contractor and Engineer of delivery schedule and requirements for off-loading and staging of media and equipment.

B. All systems and components on each train must be pre-assembled and inspected free of defects at the Supplier's facility prior to delivery to site for installation.

C. The MMF Supplier shall provide two (2) full days of field services, excluding travel time, of qualified company personnel who will be responsible for pre-start-up inspection of the filter system, and site operator training (formal and informal), and assistance at the site during system start-up.

1.8 DESIGN CRITERIA

A. System Capacity – The MMF System shall be designed for a minimum flowrate of 2,000 gpm and a maximum flow rate of 6,900 gpm and according to the following water quality information (feed stream to the MMF System).

Parameter	*Units*	*Value*	
		Average	*Maximum*
Flow	gpm	5,000	6,900
Total Suspended Solids (TSS)	ppm	40	40
Perchlorate	ppm	1.3	1.8
Sulfate	ppm	1,175	1,700
Chlorate	ppm	0.43	0.43
Chloride	ppm	493	625
Magnesium	ppm	110	135
Potassium	ppm	33	37
Sodium	ppm	510	640
Calcium	ppm	420	420
Nitrate-NO_3	ppm	30	36
Total Dissolved Solids	ppm	3,050	4,150
Total Organic Carbon	ppm	2.1	2.5
Bicarbonate	ppm	195	200

B. The system shall treat the water to produce an effluent with total suspended solids concentration no more than 5 ppm. The filters shall remove all solid particles greater than 10 microns from the influent stream.

C. The system shall have at least three (3) trains with each train consisting of one (1) filter vessel operating in parallel. Each filter vessel shall consist of two filter cells. The system shall have adequate capacity to operate at maximum influent flow and total suspended solids loading. System shall be able to treat the average flow of 5,000 gpm when one (1) vessel is out of service.

D. The filtration rate of the whole system shall be no more than 5.2 gpm/ft^2 at maximum flow rate of 6,900 gpm when all filter cells are in operation.

E. The filter media shall consist of a 6" layer of Coarse Silica Sand, a 18" layer of Fine Silica Sand with effective size 0.45-0.55 mm and the UC<1.65 and a 18" layer of Anthracite with effective size 0.8-1.0 mm and the UC<1.65.

F. The capacity of the air blower for air scouring operation shall be 612 SCFM at 5 psig.

G. Pressure Drop – Pressure drop across the system shall be no more than 15 psig at the time backwash becomes necessary (including system piping, underdrains, and media).

H. System Design and Operating Pressure – Unless otherwise specified, MMF vessels, piping, valves, and appurtenances subject to internal pressure during normal operation and backwashing (reverse normal water flow direction) shall be designed, rated, and constructed for a working pressure of not less than 100 psig at 150°F.

1.9 MODES OF OPERATION

A. The MMF System shall be operated by a PLC controller. Pre-backwash rinse shall be included in the filter cell backwash cycle, and the backwash is assisted by an air scouring system.

B. Normal Operation – The multi-media filters shall be designed for downward flow. One (1) magnetic flow meter and one (1) modulating flow control valve shall be provided at the influent stream to each train/vessel for flow measurement and evenly distribution of incoming flow to all three (3) filter trains/vessels.

C. The filter control system shall only allow one filter cell to be rinsed/backwashed at a time. Each of the filter cells shall be rinsed/backwashed once before any one of the cells is rinsed/backwashed a second time. The subsequent rinse/backwash following any rinse/backwash cycle for any filter cells shall not start less than 2 hours after the beginning of the previous rinse/backwash cycle. An interlock shall prevent the filter cells from starting a rinse/backwash sequence if the liquid level in the Backwash Waste Tank TK-3A/B and Rinse Water Tank TK-6 is higher than the permissive level.

D. Pre-Backwash Rinse Operation – Rinsing is performed to displace perchlorate-contaminated water from the filter cell before the cell is backwashed. When a filter cell is determined to be

ready for backwash by the control system, the cell shall be isolated and will be allowed to drain up to the level of filter media. After the drain valve is closed, the controller shall open the rinse water valve and rinse water discharge valve. The other vessels and the other filter cell in the same vessel shall remain in operation during the rinse operation. Treated IX effluent water containing almost no perchlorate will be used to rinse the filter cell before backwashing, and this water is supplied by Rinse/Backwashed Pumps (PU-5A/B/C). The rinse water leaving the filter will be directed to Rinse Water Tank TK-6, from where it will be transferred to the IX system for treatment. The rinsing operation will continue for at least 3 minutes, after which the rinse water valve and the rinse water discharge valve will be closed, and Rinse/Backwash Pumps PU-5A/B/C will stop. The rinse/backwash pumps (provided by others) will be used to provide rinse water from the treated water tank during this stage.

E. Air Scouring – Before backwash, air scouring is performed to facilitate the following backwash operation. With the air blower started and the air scouring valve opened, a stable air blanket is formed inside the backwash distribution header and laterals of the cell to be backwashed. The air blower will continue run for a preset time (number of minutes will be determined based on field conditions). After the blower is stopped, the air scouring valve is closed.

F. Backwash Operation –Once the air scouring is complete, the rinse/backwash valve is re-opened, and Rinse/Backwash Pumps (PU-5A/B/C) are started. The backwash discharge valve for the cell being backwashed is opened at the same time to allow backwash waste to be discharged to the Backwash Waste Tanks (TK-3A/B). Once backwashing is complete, the filter control system will then place the cell back to normal operation.

1.10 PERFORMANCE REQUIREMENTS

A. The system shall be designed to handle flow rates ranging from 2,000 gpm to 6,900 gpm with no adverse impact on performance. The system shall have adequate capacity to operate at maximum influent flow and total suspended solids loading. When one (1) filter cell is out of service, the system shall be designed to handle the average flowrate of 5,000 gpm flow.

B. The multi-media filter shall consistently remove solid particles which are equal to or larger than 10 microns from the influent stream entering the filtration system. The filtered water shall contain less than 5 ppm suspended solids.

1.11 SUBMITTALS

A. Submit under provisions of 01330 – Shop Drawings, Product Data, and Samples.

B. Shop Drawings

1. Two (2) weeks after a Notice To Proceed from the Engineer, shop drawings including but not limited to the following shall be delivered to the Engineer:

a. Project schedule indicating submittals, equipment delivery, installation, and start-up dates.

b. Flow schematic drawing indicating line sizes, valves, flow meters, pressure sensors, method of support, utility (air, water, drain, electric) line sizes and connections.

c. MMF cell/vessel shop or fabrication drawings with all dimensions indicated. Include identification and catalog cuts for purchased components and details for manufactured components. Identify materials, surface preparation, and finishes. Include ASME calculations of wall thickness for filter vessel, manways and nozzles.

d. Pressure safety valve calculations.

e. Applicable certifications and ratings.

f. Structural and seismic calculations for filter vessels. Calculations should be signed and approved by a Registered Professional Engineer within the State of Nevada. Engineer shall provide calculations for reactions at anchor bolts and selection of the size depth and number of bolts required for use with Simpson Set Epoxy anchor system.

g. Flow, quantity, pressure, quality, size, rating, and/or other parameters of raw water and utilities that should be provided at the site including washdown water, rinse water, backwashing water, drainage, and electrical.

h. Calculations of backwash flows, piping system headloss under specified operating modes, liquid flow velocities in all piping runs during normal operation and other calculations specified.

i. Detailed drawings illustrating equipment arrangement, bill of materials, weights (dry and operating), size, and location of all anchor bolts and nuts, and plan view system drawing.

j. Piping arrangement drawings or plans and elevation drawings including details (i.e., flanged etc.) and location of all required connections to utilities and piping.

k. Three-dimensional (3D) models of equipment, piping and other appurtenances to be supplied, compatible for use in Revit or AutoCAD.

l. List of any extra materials or supplies provided.

m. List of recommended spare parts.

n. List of any special tools required.

o. Supplier’s qualification as specified in Section C.

C. Test Reports – The following test reports shall be provided:

1. A test report shall be submitted by the MMF Supplier showing compliance with the specifications as described herein, along with a statement certifying that the material for shipment is equal in quality to and from the same lot as the representative sample submitted.

2. Test reports on the representative samples of media shall contain the following information:

   a. Grain size distribution analysis

   b. Average apparent specific gravity

   c. Effective size and uniformity coefficient (UC)

   d. Hardness (Moh Scale)

   e. Gravel porosity

   The reports shall be submitted at least three (3) weeks prior to the time of delivery of media.

3. Pressure test reports and certificates of inspection for the vessel in accordance with procedures for ASME pressure rating and ASME Boiler and Pressure Vessel Code. Reports shall be furnished not later than the time of delivery of the vessels.

4. Factory test and inspection reports regarding all factory-applied linings or coatings for filter vessels and piping. Reports shall indicate that the linings and coatings have been applied in accordance with these specifications on surfaces receiving the specified preparation. Records of film thickness and holiday testing shall be included. Reports shall be furnished no later than the time of delivery of the vessels.

D. Operation and Maintenance Manual – After beginning fabrication of the treatment system and at least two (2) weeks prior to scheduled training, Multi-Media Filter Supplier shall submit two (2) copies of an operation and maintenance manual including:

1. Drawings, specifications, catalog cuts, and descriptive information on the products provided.

2. Instructions for operation and troubleshooting the system including, but not limited to, cleaning and backwashing of the filter media.

E. MMF Supplier's Installation Instructions – Prior to shipment of system components, Multi-Media Filter Supplier shall submit:

1. Instructions for the field personnel on handling and installation of the system for the Engineer's information.

2. Additional instructions, beyond the detailed drawings specified herein before, if needed, for the General Contractor's installation of utilities associated with the system and anchor bolts.

1.12 DELIVERY

A. The MMF Supplier shall familiarize themselves with site constraints and characteristics prior to shipment of system components, including the media. The Supplier shall provide the Engineer one week's notice and 24-hour confirmation of his intent to deliver the system.

PART 2 – MATERIALS

2.1 MANUFACTURERS

A. The system shall be manufactured by the MMF supplier.

2.2 FILTER VESSELS

A. Vessels shall be fabricated from carbon steel and shall be fusion epoxy-lined. Equipment manufacturer shall maintain an ASME code certified shop, with ASME code certified welders.

B. The maximum operating design pressure and temperature shall be 100 psig and 150°F.

C. Two (2) pressure relief valves shall be provided for each vessel (one for each filter cell) to protect the vessel from overpressure.

2.3 PIPING

A. The filter system shall be provided with all inlet, rinse water inlet, backwash inlet and outlet piping within the train. Manifolds shall be fusion epoxy-lined carbon steel. All piping is Schedule 40 carbon steel pipe provided with 150# flange connections, except for the air scouring and overdrain pipes, which are Schedule 80 PVC.

2.4 AUTOMATIC VALVES

A. Each filter vessel shall be supplied with one (1) electrically-actuated modulating flow control valve, sixteen (16) electrically-actuated butterfly valves for filter vessel/cell isolation, drain, external source rinse, air scouring, and backwash.
B. Each filter vessel shall be supplied with two (2) spring loaded pressure relief valve, one (1) foe each filter cell.
C. Each filter vessel shall be supplied with two (2) automatic air/vacuum release valve, one (1) foe each filter cell.

2.5 FILTRATION SYSTEM UNDERDRAIN

A. The filtration system underdrain shall be header lateral type underdrain with removable 304 stainless steel wedge wire laterals or equal. The underdrain shall provide even, non-turbulent media bed fluidization and shall require a gravel pack and coarse silica sand interface media.

2.6 FILTRATION MEDIA

A. Media shall be supplied consistent with system application requirements. Graded layers of anthracite and fine silica sand shall be supported by a layer of coarse silica sand as interface layer, and a layer of gravel pack.

B. Typical media configuration shall be as follows or equal:

1. Top Layer - 18 inches of anthracite with effective size 0.8-0.1 mm and UC<1.65

2. Second Layer – 18 inches of fine silica sand with effective size 0.45-0.55 mm and UC<1.65

3. Third Layer – 6 inches of coarse silica sand (interface layer)

2.7 AUTOMATIC CONTROL

A. The filter system shall include an Allen Bradley PLC based control system with 15-inch color touch screen HMI housed in a NEMA 4X enclosure or equal. This controller will provide automatic pre-backwash rinse, air scouring and backwash based on a pre-set pressure differential (i.e., drop) across the media filter or on a time-selected interval. In addition, there shall be included a field-adjustable automatic pressure differential (P.D.) override safety circuit. The filters will be cleaned on a time-scheduled basis; however, if the source water quality varies and/or the pressure differential increases to a pre-set limit prior to the scheduled backwash time, the P.D. circuit will activate a rinse and backwash cycle. A backwash cycle counter shall be integral to the controller. Controller shall be 110 VAC powered. One (1) controller shall be provided to control all filter trains. The trains will be rinsed and backwashed one filter cell at a time.

2.8 INSTRUMENTATION

A. One (1) pressure differential transmitter shall be provided for each train.

B. Two (2) magnetic flow meters are to be provided per train, one for process water and one for backwash flow stream.

PART 3 – EXECUTION

3.1 INSTALLATION OF EQUIPMENT (NOT USED)

3.2 INSTALLATION OF FILTER MEDIA (NOT USED)

3.3 TESTING AND START-UP (NOT USED)

END OF SECTION

SPECIFICATION REVISION INDEX

Revision No.	Revision Date	Issued for	Signatures				
			Prepared By	Reviewed By	Project Engineer	Project Manager	Client
A	11/28/2016	60% Submittal	WX	JG	JG	STD	
B	1/27/2017	DRAFT 90% Submittal	WX	JG	JG	STD	
C	2/15/2017	75% Submittal	WX	JG	JG	STD	

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SECTION 11220

ION EXCHANGE SYSTEM

TABLE 1: SUMMARY OF PROCESS PARAMETERS

Parameter	Units	Value
Average Flowrate	gpm	5,000
Maximum Flowrate	gpm	6,900
No. of Trains	Ea.	At least three (3), with each train having lead and lag vessels
Average influent perchlorate concentration	ppm	1.3
Maximum influent perchlorate concentration	ppm	1.8
Maximum influent TSS concentration	ppm	10.0
Target effluent perchlorate concentration out of lag vessel	ppb	4.0
Maximum pressure drop across system	psi	60
Maximum Operating Pressure	psi	125
Maximum Operating Temperature	°F	150

SECTION 11220

ION EXCHANGE SYSTEM

PART 1 – GENERAL

1.1 DESCRIPTION

A. This section describes materials, fabrication, installation, and testing of a complete pre-engineered Ion Exchange (IX) System described herein for the removal of perchlorate from water. The Ion Exchange Supplier shall be responsible for the vessels, piping, valves, flowmeters, controls, and the loading of fresh resins in the vessels. The Ion Exchange Supplier shall also be responsible for the removal of the spent resin from the tanks and the disposal of spent resin using incineration method. Disposal of exhausted resin in a landfill is not permitted.

B. The system shall be capable of treating up to 6,900 gpm of influent flow at perchlorate concentration which may range from 1.3 to 1.8 mg/L with one (1) vessel out of service. The system shall produce a treated water flow with a perchlorate concentration of 4.0 μg/L or less from each lag vessel.

1.2 RELATED REQUIREMENTS

A. Section 01330—Shop Drawings, Product Data, and Samples

B. Section 01400 – Quality Control

C. Section 01600 – Common Product Requirements

D. Section 01630 – Product Options and Substitutions

E. Section 01730 – Operation and Maintenance Data

F. Section 01810 – Starting of Systems

G. Drawing I-701 – Ion Exchange IX-1A/2A P&ID

H. Drawing I-702 – Ion Exchange IX-1B/2B P&ID

I. Drawing I-703 – Ion Exchange IX-1C/2C P&ID

1.3 COORDINATION

A. The Ion Exchange (IX) System Supplier will be responsible for providing and delivering equipment and appurtenances to the project site as specified herein.

B. The equipment shall be installed by the General Contractor, who will be responsible for off-loading the equipment, providing any temporary storage in accordance with the Supplier's recommendation for storage and installing the equipment in place.

1.4 WORK TO BE INCLUDED

A. The IX System Supplier shall be responsible for supplying all system components needed to operate the ion exchange system per the specification, including, but not limited to, ion exchange vessels and resin, interconnecting piping, wiring and electrical connections, valves, instruments, supports, anchors and all accessories within the train required for a complete and working system. The IX System Supplier shall be responsible for the design, engineering, fabrication, delivery, unloading, and setting of the trains and all mechanical components, including vessels, piping, valves and instrumentation on concrete pads. The IX Supplier shall provide two (2) days of operator training and start-up at the site.

B. The system shall consist of at least three (3) trains. Each train shall have two (2) vessels and manifold that will allow for a lead/lag configuration. Influent water shall flow through a header to each of ion exchange trains, which are operated in parallel. The lead and lag vessels of each train shall be interchangeable by turning on/off valves.

C. Interconnecting piping within each train shall have water flow direction clearly labeled.

D. The IX System Supplier shall be responsible for the supply, delivery, and hydraulic loading of the fresh IX resin for start-up.

E. The IX System as specified herein shall be comprised of:

1. At least three (3) trains consisting of two (2) downflow exchange vessels/systems to provide redundancy. The system shall have adequate capacity to operate at maximum influent flow and perchlorate loading with one (1) vessel out of service.
2. Interconnecting process and utility piping, wiring and electrical connections, valves, flow meters, and accessories for each train which may be necessary for the proper operation of the filtration system.
3. Independent IX resin fill and discharge piping.
4. Vent and pressure relief piping and flush water connections.
5. Air connections for IX resin transfer.
6. Pressure drop gauges on each IX vessel, and sample ports.
7. Rupture Disc for each IX vessel.
8. Resin for each IX vessel.
9. One (1) complete set of technical specifications and plans and two (2) sets of operation and maintenance manuals.
10. Training of site operators by certified representative for two (2) 8-hour days excluding travel time.

F. The Ion Exchange Supplier shall also provide Resin Exchange Turnkey Service during the system operation period, which shall be comprised of:

1. All labor, freight and equipment associated with the transport, supply and loading of the fresh resin into the resin tanks, and the off-loading, transport and disposal of the spent resin.
2. A direct employee of the Resin Manufacturer shall be on site to assist with the initial resin loading and all resin exchange services.
3. Spent resin shall be incinerated at a facility approved by the Engineer.
4. All labor and equipment required by the resin exchange operation, which includes, but not limited to, truck and/or trailer, pipe and hose, air compressor, and pumps if required.
5. Prior to reloading the empty IX vessel with fresh resin, inspection and photography of the empty vessel interior for each resin replacement and provide inspection results to the Engineer.
6. After each resin exchange, the IX System Supplier shall be responsible to switch the original lag vessel to the lead vessel, the new exchanged resin vessel to the lag vessel, and prepare the system to be placed back into operation once the resin service has been completed and approved by the Engineer.
7. All fresh resin shall be pre-washed before shipping to the site for installation.

G. Work by Others

1. Reinforced concrete foundations
2. Final anchoring of equipment to foundations
3. Influent header into system
4. Treated water header out of system
5. Electrical power supply.

1.5 SUPPLIER'S QUALIFICATIONS

A. The Supplier of the IX System equipment shall have the following minimum qualifications:

1. Have previously designed, engineered and furnished five (5) IX treatment systems, for the reduction of perchlorate, within the United States, designed for a minimum of 1,000 gpm per vessel. Systems cited in experience submittals shall have downflow, pressure-type configurations using the same vessel diameter and design, and meeting these specifications. The Supplier shall have had complete system responsibility, including installation on at least one of the systems.

2. Have furnished at least one similar IX system currently in use and removing perchlorate from the influent water stream. This system shall be designed to treat at least 1,000 gpm/vessel.

3. Have a minimum of five (5) years' experience in IX handling aspects pertaining to the loading of IX Resin and unloading of spent IX Resin using bulk trailers.

4. Have a minimum of five (5) years' experience in disposal and/or treatment of spent resins using the incineration method.

5. Provide three (3) references, with contact information, for systems described above.

1.6 WARRANTY

A. The IX System Supplier shall guarantee all equipment to be free of defects in material and workmanship for a period of 18 months from date of delivery of the equipment or 12 months from the date of final acceptance, whichever is longer.

1.7 ION EXCHANGE SYSTEM SUPPLIER INSTALLATION SERVICES

A. The IX System Supplier shall inspect all equipment upon delivery to the site and repair or replace damaged equipment. The IXS Supplier shall coordinate with the Engineer for all necessary activities including delivery, off-loading and staging of resin and equipment, scheduling, site safety, authorization of construction personnel, and site responsibilities.

B. All systems and components on each train must be pre-assembled and inspected free of defects at the Supplier's facility prior to delivery to site for installation.

C. The IX System Supplier shall provide two (2) full days of field services, excluding travel time, of qualified company personnel who will be responsible for pre-start-up inspection of the IX System, site operator training (formal and informal), and assistance at the site during system start-up.

1.8 DESIGN CRITERIA

A. System Capacity – The IX System shall be designed for a minimum flowrate of 2,000 gpm and a maximum flow rate of 6,900 gpm and according to the following water quality information (influent flow into the Ion Exchange System):

Parameter	*Units*	*Value*	
		Average	*Maximum*
Flow	gpm	5,000	6,900
Perchlorate	ppm	1.3	1.8
Sulfate	ppm	1,175	1,700
Chlorate	ppm	0.43	0.43
Chloride	ppm	493	625

Magnesium	ppm	110	135
Potassium	ppm	33	37
Sodium	ppm	510	640
Calcium	ppm	420	420
Nitrate-NO_3	ppm	30	36
Total Dissolved Solids	ppm	3,050	4,150
Total Suspended Solids (TSS)	ppm	10	10
Total Organic Carbon	ppm	2.1	2.5
Bicarbonate	ppm	195	200

B. The system shall treat the water to produce treated water with perchlorate concentration no more than 4 ppb from the effluent of each IX train.

C. The system shall have at least three (3) trains to provide redundancy. The system shall have adequate capacity to operate at maximum influent flow and total suspended solids loading.

D. Pressure Drop – Pressure drop across the system shall be limited to 60 psig (including system piping, underdrains, and resin) when operated at system capacity (6,900 gpm).

E. System Design and Operating Pressure – Unless otherwise specified, IX vessels, piping, valves, and appurtenances subject to internal pressure during normal operation, rinse (if required), or IX filling or removal shall be designed, rated, and constructed for a working pressure of not less than 125 psig at 150°F.

1.9 MODES OF OPERATION

A. IX Normal Operation – The IX System shall be designed for downward (co-current) flow. A flow meter shall be provided at the inlet of the lead vessel of each train for flow measurement during normal operation.

B. IX Rinse Operation – A rinse port and blind flange are included for plumbing to drain for removal of water during Resin exchange.

C. IX Resin Removal and Replacement – System shall be designed and constructed to allow one (1) IX vessel on one (1) train to be isolated for removal of spent IX without interrupting the treated flow through the entire system. The lag vessel will continue to treat water during the resin exchange on the lead vessel. IX resin removal shall be accomplished by pressurizing the vessel with compressed air to displace the spent IX and water into an empty shipping container or trailer (provided by the IX System Supplier). The bottom of the IX vessel and slurry piping shall be designed to allow complete removal of spent IX resin from the exchange vessel and piping, using manual hosing from the access manholes if necessary. IX System Supplier shall inspect and photograph the empty vessel interior for each resin replacement and provide inspection results to the Engineer.

1.10 PERFORMANCE REQUIREMENTS

A. The system shall be designed to handle flow rates ranging from 500 gpm to 6,900 gpm with no adverse impact on performance. The system shall have adequate capacity to operate at maximum influent flow and perchlorate loading.

B. The system shall be capable of producing treated water containing no more than 4.0 ppb perchlorate from each lag vessel during both normal and resin replacement operating modes.

1.11 SUBMITTALS

A. Submit under provisions of 01330 – Shop Drawings, Product Data, and Samples.

B. Shop Drawings

1. Three (3) weeks after a Notice To Proceed from the Project Manager, Approval drawings including but not limited to, the following shall be delivered to the Engineer:

   a. Project schedule indicating submittals, equipment delivery, installation, and start-up dates.

   b. Flow schematic drawing indicating line sizes, valves, flow meters, method of support, utility (air, water, drain, electric) line sizes and connections.

   c. Exchange vessel approval drawings with all dimensions indicated. Include identification and catalog cuts for purchases components and details for manufactured components. Identify materials, surface preparation, and finishes. Include calculations of wall thickness for exchange vessel.

   d. Rupture disc calculations for each exchange vessel.

   e. Applicable certifications and ratings.

   f. Structural and seismic calculations for filter vessels. Calculations should be signed and approved by a Registered Professional Engineer within the State of Nevada. Engineer shall provide calculations for reactions at anchor bolts and selection of the size depth and number of bolts required for use with Simpson Set Epoxy anchor system.

   g. Flow, quantity, pressure, quality, size, rating, and/or other parameters of raw water and utilities that should be provided at the site including wash down water, rinse water, drainage, and electrical.

   h. Calculations of piping system headloss under specified operating modes, liquid flow velocities in all piping runs during normal operation, pipe support and other structural calculations, and other calculations specified.

i. Detailed drawings illustrating equipment arrangement, bill of materials, weights (dry and operating), size, and location of all anchor bolts and nuts, and plan view system drawing.

j. Piping arrangement drawings or plans and elevation drawings including details (i.e., flanged etc.) and location of all required connections to utilities and piping.

k. Three-dimensional (3D) models of equipment, piping and other appurtenances to be supplied, compatible for use in Revit or AutoCAD.

l. List of any extra materials or supplies provided.

m. List of recommended spare parts.

n. List of any special tools required.

o. Supplier's qualification as specified in Section C.

C. Samples – if so requested by the Engineer, samples of the IX Resin provided for the initial filling of exchange vessels shall be provided.

1. A test report shall be submitted by the IX System Supplier showing compliance with the specifications as described herein, along with a statement certifying that the material for shipment is equal in quality to and from the same lot as the representative sample submitted. IX System Supplier shall supply a Certificate of Analysis from the Resin Manufacturer for each batch supplied to the project.

2. Test reports on the representative samples of IX Resin shall contain the following information:

   a. Apparent density
   b. Mesh size confirmation and mean diameter
   c. Effective size
   d. Resin moisture levels
   e. Volume capacity

   The reports shall be submitted at least three (3) weeks prior to the time of delivery of the IX System.

3. Pressure test reports and certificates of inspection for the vessels in accordance with procedures for ASME pressure rating and ASME Boiler and Pressure Vessel Code. Reports shall be furnished not later than the time of delivery of the vessels.

4. Factory test and inspection reports regarding all factory-applied linings or coatings for exchange vessels and piping. Reports shall indicate that the linings and coatings have been applied in accordance with these specifications on surfaces receiving the specified preparation. Records of film thickness and holiday testing shall be included. Reports shall be furnished not later than the time of delivery of the vessels.

D. Operation and Maintenance Manual – After beginning fabrication of the treatment system and at least two (2) weeks prior to scheduled training, IX System Supplier shall submit two (2) copies of an operation and maintenance manual including:

1. Drawings, specifications, catalog cuts, and descriptive information on the products provided.
2. Instructions for operation and troubleshooting the system.
3. Instructions for removal of spent IX resin and replacement with new IX resin, including any auxiliary utilities required and any safety procedures to follow.
4. Control Narrative

E. IX System Supplier's Installation Instructions – Prior to shipment of system components, IX System Supplier shall submit:

1. Instructions for the field personnel on handling and installation of the system for the Engineer's information.
2. Additional instructions, beyond the detailed drawings specified herein before, if needed, for the General Contractor's installation of utilities associated with the system and anchor bolts.

F. Health and Safety Plan – The IX System Supplier shall submit their recommended health and safety plan for all personnel involved in handling spent IX resin that may contain hazardous materials.

1.12 REGULATORY REQUIREMENTS

A. The IX System Supplier shall comply with all applicable regulatory requirements including, but not limited to, the following:

1. Occupational safety and health requirements of OSHA.
2. U.S. Department of Transportation requirements for transportation of IXS and IX Resin.

B. The IX System Supplier shall provide evidence of compliance with applicable permits where specifically required in these specifications. Additional evidence (copies of permits, etc.) shall be provided if requested by the Engineer. The IX System Supplier shall obtain all necessary permits related to the delivery of the system at his own expense.

1.13 FIELD SAMPLES

A. The Engineer reserves the right to obtain samples of any materials provided by the IX System Supplier at the project site (field samples) to verify compliance with these specifications. Field samples may be obtained in addition to samples provided from the factory by the IX System Supplier. Where the Engineer's collection of a sample will result in the need for repair or replacement of a fabricated item, the Engineer shall reimburse the IX System Supplier for

repair or replacement at a mutually agreeable price.

1.14 DELIVERY, STORAGE, AND HANDLING

A. The IXS Supplier shall familiarize themselves with site constraints and characteristics prior to shipment of system components, including IX Resin. The IX System Supplier shall provide the Engineer one week's notice and 24-hour confirmation of his intent to deliver the system.

B. All IX resin should be stored in such a manner as to prevent any direct sunlight or freezing of the media, if not installed in a timely manner.

1.15 STORAGE AND PROTECTION

A. System components delivered to the site shall be stored in such a manner that they will not constitute an attractive nuisance or safety hazard.

1.16 PROJECT/SITE CONDITIONS

A. IX System Supplier shall familiarize himself with current and proposed site conditions, including improvements for this project by others, before equipment and IX Resin deliveries and installation of system. The IX System Supplier shall not operate any existing facilities without Engineer's consent or cause water spill to the ground at this facility.

1.17 ENVIRONMENTAL REQUIREMENTS

A. The IX System Supplier shall minimize unnecessary traffic at and around the site. Rubbish, waste, and litter shall be stored in proper containers and removed from the site in a timely manner so as not to create a nuisance or eyesore in the Engineer's opinion. Discharges of any materials to streets, storm drains, or to the sanitary sewer shall not permit without the express written permission from the Engineer.

PART 2 – MATERIALS

2.1 MANUFACTURERS

A. The system shall be manufactured by the IX System Supplier.

2.2 ION EXCHANGE VESSELS

A. Exchange vessels shall be vertical, cylindrical pressure vessels with elliptical or flanged and dished top and bottom heads. Vessel bottoms and appurtenances shall be designed for complete removal of spent IX Resin and even distribution of treated water. Vessels shall be designed, constructed, tested, certified, and stamped in accordance with the most recent revision of the ASME Boiler and Pressure Vessel Code, Section VIII.

B. Vessels shall be constructed of carbon steel.

C. Vessels shall be provided with all necessary support, baffles, influent and effluent screens and accessories required to provide a uniformed flow to the resin bed.

D. The maximum operating design pressure and temperature shall be 125 psi at 150°F.

E. The vessel, support structure, and all other shop assembled appurtenances of the system module shall be reinforced and supported with structural members as required such that the assembled components can be transported and off-loaded without distortion. The components shall be provided with lifting lugs to enable setting the equipment on a concrete foundation with a suitable capacity crane. System supports shall be designed and drilled for installation and anchoring to concrete foundation. Structural components shall conform to ASTM A 36 specifications.

F. All interior clips and piping supports for the underdrain and distributor system, the rinse spray head supports, or any other support brackets shall be fabricated using 316L SS. All clips shall be welded to a backup plate with rounded corners. The backup plates shall be 3/8-inch-thick 316L SS, shall be rolled or formed to the vessel's contour, and shall be fabricated and installed so that the backup plate's edge is at least 2 inches from the clip's edge. This will provide a stainless steel base for the stainless steel clips that can be properly welded, ground and coated with the internal lining. The lining shall cover the base plate and not cover the clip. All members utilized for bracketing and support clips shall adequately provide for axial, lateral, or torsional loading resistance. Any flanged fitting or coupling used to support or connect interior pipe shall be of 316L stainless steel. Spools that connect internal to external process piping can be fabricated of Schedule 80 carbon steel if the internal flange is 316L SS and properly welded to the carbon steel, ground and coated with the internal lining.

G. Vessel Access: A minimum of two (2) accessways shall be provided on each vessel. One access way on the top head, equipped with a stainless steel chain to prevent the cover from falling. The second manway shall be located on the side shell near the bottom but above the underdrain system. The manways shall be circular with a minimum of 20 inches in diameter. The manways shall be sized to accommodate the repair and/or removal of the largest single internal component. Removable davits or hinge system shall be provided to support the manway cover when opened or removed from the vessel.

H. Vessel Nozzles: Each vessel shall be provided with a minimum of the following nozzles:

1. Feed water inlet.
2. Treated water outlet/rinse inlet
3. Inlet for IX Resin.
4. Outlet for spent IX Resin.
5. Potable water connection above the Ion Exchange bed for spray nozzle insertion.
6. Combination air and vacuum release valve installed at the high point of the vessel.

I. Sample Probes: Sample taps shall be located in the inlet and outlet piping of each vessel.

J. Underdrain System

1. Underdrain system to be utilized shall be external removable septa.

2. The underdrain system shall provide the following performance, design, and materials criteria:

    a. The maximum design flow rate per vessel in normal operating mode, depending on the number of trains to be supplied.

    b. The fluid velocity through the screened area shall not exceed 2.2 feet per second.

        i. IX System Supplier must submit with bid engineering and hydraulic calculations to support proposed design meets or exceeds underdrain hydraulic parameters.

    c. Underdrain system shall be designed to prevent lateral movement in either direction. Use of bands is not permitted.

    d. All stainless steel threaded connections shall be made with Teflon tape.

    e. Design shall facilitate IX Resin change-out.

    f. The underdrain shall be designed such that the IX Resin will be retained by the bottom underdrain screens when the vessel is in normal operation.

    g. Underdrain designs utilizing plastic or fiberglass reinforced plastic (FRP) pipe, plastic distributors, sand, gravel, and concrete will not be accepted.

3. Underdrain designs utilizing an external septum shall include the following additional design parameters:

    a. External ring header shall be Schedule 40 carbon steel pipe and fittings.

    b. Externally-removable vertical septa shall be equally spaced in the bottom head of the IX vessel.

    c. Bayonet septa shall be 316L stainless steel.

    d. Each septum screen shall be reinforced to support the maximum hydraulic loading.

K. Upper Distributor: The upper distributor shall meet the following criteria:

1. Flow conditions shall be as listed for the underdrain system.

2. All upper distributor material internal to the exchange vessel shall be 316L stainless steel.

3. If screens are used in the upper distributor, sufficient open slot area shall be provided to allow for the free passage of accumulated IX Resin fines, silts, and clays to waste. Therefore, the screens must not be attached to the distribution header or laterals by stainless steel to stainless steel pipe threads.

4. All support structures shall be fabricated of 316L stainless steel, use bolting rather than "band-it" banding.

L. Lining:

1. All carbon steel surfaces on the interior of the exchange vessels shall be prepared and coated in a controlled shop environment by the IX System Supplier. All surfaces shall be prepared in accordance with SSPC-SP5 including nozzles and penetrations. All welds, sharp edges, and fillets shall be ground to a smooth radius of at least 1/8 inch minimum. Weld slag, slivers, delaminations, scabs, and slip welds shall be completely removed prior to abrasive cleaning. Steel components must be prepared as per Plasite application specification for Plasguard 4110 for process and storage vessels as well as National Association of Corrosion Engineers RP 0178-95.

2. The interior of the exchange vessels shall be coated in order to prevent corrosion that will occur when IX Resin is in contact with carbon steel. This coating shall exhibit abrasion-resistant qualities to prevent erosion by movement of the resin.

3. Application of coating shall be performed by persons experienced with applying this type of coating and shall be specifically recommended by the coating manufacturer. Shelf life and handling requirements for this coating shall be strictly observed. IX System Supplier shall document and report coating formulation and application dates.

4. Where supports, brackets, clips, and similar items of stainless steel are attached to the interior of the vessels, coating shall extend a minimum of 1 inch onto the backup plate from the vessel wall for immersion service.

    a. Lining inspection to be performed shall include:
    b. General appearance -film shall be free of runs, sags, orange peel, pinholing, fisheyes, overspray, trash in the film, and voids.
    c. Film thickness shall be determined using a micro test thickness gauge as manufactured by KTA-Tater, Inc., or functionally equivalent nondestructive dry film thickness gauge for use on protective coatings with an accuracy of ±5 percent and which has been properly calibrated. The number of thickness measurements shall conform to SSPC-PAS requirements.
    d. Discontinuity void testing shall be performed using a high-voltage detector Model AP-W as manufactured by Tinker and Rasor (San Gabriel, California).
    e. The void testing shall be conducted and paid for by the IXS Supplier at the lining application/curing site. Any voids or cracks found shall be repaired and retested prior to shipment by the IXS Supplier at their own expense.

2.3 PROCESS AND UTILITY PIPING

A. General

1. All pipes which will operate under pressure shall be properly tied or blocked, restrained, and supported at all fittings where the pipe changes direction, changes size, or ends, using suitable anchors. Exposed pipe shall be installed in straight runs parallel to the axes of the structures or equipment. Pipe runs shall be horizontal and vertical except that gravity drain lines shall be pitched down in the direction of flow not less than 1/8 per foot.

2. Pipe work shall be suspended and supported in such a manner as to prevent sagging or overstressing of pipe and connections and, furthermore, shall be supported so that no item of the piping system will transfer any load or stress to any equipment.

3. Piping shall be made up with a sufficient number of union, flanged joints, grooved end joints, or flexible couplings to permit ready breaking of lines as necessary for inspection and maintenance and to allow for expansions and contraction and general flexibility.

4. Pipe and fittings shall be assembled so there will be no distortion or springing of the pipelines. Flanges, unions, flexible couplings, and other connections shall come together at the proper orientation. The fit shall not be made by springing any piping nor shall orientation alignment be corrected by taking up on any flange bolts. Flange bolts, union halves, flexible connectors, etc., shall slip freely into place. If the proper fit is not obtained, the piping shall be altered to fit.

5. Piping shall be provided for raw and treated water, spent and fresh IX slurry, vents, pressure relief, compressed air potable water, rinse water, drains, IX disinfection, and sample and instrument tape.

6. Piping shall be designed for a maximum liquid velocity of 8 fps unless otherwise noted. IXS Supplier shall submit calculations to verify that requirements for maximum headloss and velocity are met with his proposal piping design. Noise generation shall be a consideration in the selection of size for pipe and valves.

7. Exceptions to the maximum velocity requirement may be permitted on relatively short piping runs where the treated waterline can serve as the rinse inlet and where the raw waterline serves as the rinse outlet.

8. Piping assemblies with valves fittings and vessels shall be pre-assembled and pressure tested at 125 psig for four (4) hours minimum at the fabrication site to assure fit-up and system integrity.

B. Piping Larger Than 2 Inches

1. Unless otherwise specified, piping shall be Schedule 40 carbon steel conforming to ASTM A 53, Grade B, Type E or S.

2. Fittings shall be flanged or welded.

C. Air Piping 2 Inches and Smaller

1. Unless otherwise specified, piping shall be Schedule 40 galvanized carbon steel conforming to ASTM A 53, Grade B, Type E or S.

2. Fittings shall be screwed, welded, or flanged.

D. IX Resin Transfer

1. Piping and fittings shall be Schedule 40 epoxy-lined carbon steel pipe.

2. Flanges shall be 150# carbon steel.

2.4 FITTINGS

A. Flanges and flanged fittings shall conform to ANSI B16.5.

1. Bolts and nuts for flanges shall be hot-dip galvanized grade 5.

2. Gaskets shall be 1/16 to 1/8-inch thick for piping 18 inches and smaller and shall be one of the following non-asbestos materials: EPDM or Red rubber.

3. Flanges at site piping interface connection points shall be AWWA C207, Class D, raised face flanges.

B. Threaded fittings shall be Schedule 40, conforming to ANSI B16.3 or forged-steel fittings conforming to ANSI 16.11.

C. Butt-welded steel fittings shall be carbon steel pipe of the same wall thickness as adjoining pipes conforming to ASTM 234 WPB and ANSI B16.9.

2.5 PROCESS VALVES

A. General

1. The IX System Supplier shall furnish all valves as called for in these specifications, or as required for proper operation of the equipment in all operating modes, including rinse mode. Valves shall be manufactured by a manufacturer whose valves have had successful operational experience in comparable service. The valve manufacturer shall furnish detailed technical information as required by the Engineer for evaluating the quality of the valves and as required by the Supplier for proper valve installation. The technical information shall include complete dimensions, weights, and material lists. No valve will be approved for installation until the required information has been received and reviewed.

2. The IX System Supplier shall furnish all incidental materials necessary for installation of the valves such as flange gaskets, flange bolts and nuts, valve boxes and covers, and all other materials required for the complete installation.

3. Manually operated valves shall be located not more than 6 feet above the operating level and shall be provided with tee handles, wrenches, or handwheels as is specified or appropriate. Valves over 5 feet to centerline shall be rolled toward the operating side to make the handwheel or wrench more accessible to the operator of average height. Valves shall be installed in all cases so handles clear all obstructions when moved from full-open to full-closed position.

B. Butterfly Valves

1. Butterfly valves shall be non-directional, wafer-type or short-body, flanged type, and rating for minimum working differential pressure across the valve disc shall be 150 psi. Flanged ends shall be Class 125, ANSI B16.1. Valve stems shall be Type 416 or 316 stainless steel. Materials of construction shall be as follows:

Component	Material	Specification
Body	Cast iron or Ductile iron	ASTM A48, Class 20, ASTM A 126, Class B; or ASTM A 536, Grade 54-45-12
Discs	Stainless steel	ASTM B 148, ASTM A 536, Grade 65-45-12
Seat material	Buna-N or EPDM	--

2. Manual actuators on valves 6 inches and larger shall be gear actuators with hand wheels or electric per process flow diagrams and shall have a position indicator or limit switch designating the opened and closed position of the valve.

C. Ball Valves

1. Valves in IX piping and sample probe lines shall be full-bore stainless steel. Bodies, balls, and stems shall be Type 316 stainless steel. Seats shall be PTFE, and stem seals shall be PTFE or Viton.

2. Valves for carbon steel piping, including flush connections, pressure gauges, and compressed air connections shall be bronze, forged brass, or barstock brass body rated for 500 psi at 100°F. Seats and seals shall be PTFE.

3. Combination Air and Vacuum Release Valves: Combination valves shall be provided and have an operating pressure of 200 psi with 1-inch screwed or flanged fitting. Valves shall be APCO, Val-Matic, or equal. Vent line shall be piped to convenient with shut off valve.

2.6 INSTRUMENTATION

A. Each train shall be provided with one (1) flow meter and located such that it can be utilized during normal operating mode (positive flow rate reading) and during rinse operating mode (if required). Flow meters shall be pipe flanged instrument to measure flow, with the following features.

1. Meter shall indicate, totalized flow in full pipes with digital readout in gallons for normal and reverse flow.
2. Shall be NEMA 4X rated.
3. Meter shall be magmeter type, manufactured by Siemens or equal.

B. Pressure Gauges: The adsorber piping network shall be equipped with pressure gauges to indicate the pressure of water entering and exiting the adsorber to provide information on the pressure drop across the adsorber. Range shall be 0-160 psi with an accuracy of 1% of full range. Gauges shall not be less than 2-1/2 inches in diameter. Pressure gauge assemblies shall be isolated from process piping with a ½-inch bronze ball valve. Gauges shall be hermetically sealed with stainless steel or bronze bourdon tube.

2.7 ACCESSORIES

A. Spray Nozzle: Spray water piping for washdown of the vessel during and after spent IX transfer shall extend to the spray wash nozzle in the top dish of each vessel. This line shall be provided with a 2-inch ball valve and located at an operable elevation and shall provide quick connect for service water. A full cone spray will be installed in the top dish.

B. Flush Connections: Two flush connections shall be provided on each resin transfer line, one upstream and one downstream of the ball valve (four connections per vessel). Flush connections shall consist of a short section of 1-inch pipe and a 1-inch full port ball valve and 1-inch quick disconnect adapter to match air hose fittings.

C. Transfer Hose Connectors: The IX Slurry piping shall be fitted with hose connectors, such that IX Resin transfer to and from the exchange vessels can be facilitated with transfer hoses. These connectors shall be 4-inch quick disconnect adapters constructed of 304 stainless steel or aluminum as manufactured by OPW Division of Dover Corporation as Kamlock Part No. 633-F, or equal.

D. Sample Piping:

1. The following sample taps shall be provided as a minimum:
   a. Raw water to the exchanger.
   b. Treated water from the exchanger
2. The raw water to the exchanger and treated water from the exchanger shall be ½-inch diameter stainless steel tubing with ½-inch diameter bronze ball valves.

2.8 PAINTING AND COATING OF VESSEL EXTERIORS, PIPING, VALVES, AND METAL

A. Exposed Metal Coating System

1. Surface Preparation: SSPC SP-6

2. Prime Coat: Carboline 888 epoxy primer or equal applied to minimum dry film thickness per manufacturer recommendations.

6. Finish Coat: Carboline 133 Polyurethane or equal applied to minimum dry film thickness per manufacturer recommendations.

B. Surfaces Not to be Coated:

1. Aluminum, brass, bronze, copper, plastic, rubber, stainless steel, or galvanized, grease fitting, nameplates, or serial numbers.

2.9 ION EXCHANGE RESIN

A. Resin Manufacturer's Qualifications

1. The IX Resin shall be supplied by a manufacturer who is experienced in the design and application of IX Resin for perchlorate removal treatment.

2. The IX Resin supplied shall all be manufactured at the same plant.

3. The IX Resin Manufacturer shall have been in the business of supplying IX Resin for a minimum of 10 years and have in place a Quality Control, Quality Assurance protocol sufficient to insure homogeneous properties and specification compliance for each lot number provided under this contract.

B. Technical Requirements

1. The IX Resin shall be suitable for use as an exchange media in perchlorate removal in water treatment and be effective in the removal of the target inorganic ions described herein to the prescribed acceptable levels.

2. The IX Resin shall be durable and capable of withstanding the abrasion associated with sluicing.

3. The IX resin shall meet the minimum standards and performance criteria regarding material specifications and physical properties. These performance criteria shall be evaluated based on samples of the proposed material which are submitted to the Engineer, such as lab reports and the Engineer's on-site tests of the delivered material. Failure of samples to meet the performance criteria shall result in rejection of the IX Resin and, in the case of job-site samples, in the removal and replacement of any installed materials at no cost to the Engineer.

4. Detailed specifications and material quality and testing results shall be submitted to the Engineer for review and approval prior to delivery, and installation of the IX Resin. Resin Manufacturer's test reports shall include the following information:

   a. Manufacturer's name

   b. Material source and manufacturer plant location

   c. Date of sampling

   d. Lot or stockpile number identification

   e. Demonstration of compliance with physical properties and specifications

5. The Engineer will have two (2) weeks from the date of delivery of the representative sample of the IX Resin, corresponding test results, and certifications as outlined above to notify the supplier in writing of shipment quality acceptance.

PART 3 – EXECUTION

3.1 INSTALLATION OF EQUIPMENT

A. Erection:

1. Field erection of factory equipment shall be in strict accordance with the Supplier's recommendations.

2. Particular care shall be exercised in handling and bolting of the equipment, supports and members to avoid abrasion, and misalignment.

3. Touch-up coating shall be done in accordance with the paint specifications and Supplier's recommendations.

B. Testing:

1. Following completion of assembly, system shall be pressure tested for liquid tightness by filling vessels.
2. Any leaks by the test shall be corrected by the IX System Supplier.
3. The Engineer will provide clean water free of charge at the time of testing of the system.
4. Filling and emptying of the system shall be the responsibility of the IX System Supplier. IX System Supplier shall coordinate discharge location of clean water with Engineer.

3.2 INSTALLATION OF RESIN

A. Following testing, inspection, the exchange vessel shall be filled with IX Resin per vessel in accordance with the specifications.

B. IX System Supplier shall deliver IX in trailers provided by IX System Supplier. Trailers shall be thoroughly cleaned prior to filling with IX Resin.

C. IX resin shall be pre-washed at the shop before being shipped out for installation.

D. Makeup or rinse water needed for the transfer will be provided by the Engineer. The IX System Supplier shall provide any necessary hoses, site glasses, piping, and appurtenances for using this water. The compressed air supply required for transfer of IX Resin shall be provided by the IX System Supplier.

E. All water used in the transfer process shall be discharged to the point on site designated by the Engineer. No discharges will be permitted without the Engineer's permission.

F. IX Resin shall be transferred as water slurry only, using air pressure on the trailer as the motive force. Use of a pump or eductor to transfer the IX Resin from the trailer into the exchange vessel will not be allowed. Bag loading or dry loading of the IX resin into the exchange vessel is prohibited. The IX resin shall be loaded into the trailers before the units are driven on to the site.

G. The IX System Supplier will be responsible for cleanup of all IX Resin and slurry spills that may occur during the IX Resin transfer operation.

H. Following installation of the IX Resin in all exchange vessels, the IX System Supplier shall assist the Engineer's operating personnel in placing the system in initial operation in the filter-to-waste and rinse modes. When the beds have been adequately rinsed and are ready for normal operation, the IX System Supplier shall so advise the Engineer and assist with placing the system in operation.

3.3 TESTING AND START-UP (NOT USED)

3.4 RESIN REPLACEMENT

A. The IX System Supplier shall be responsible for the depleted resin replacement and the transport and disposal of the depleted resin using the incineration method as indicated in Item 1.3.F of this Specification. Engineer will coordinate with the IX System Supplier when resins in one or more vessels has depleted and vessel effluent perchlorate concentration is above the target limit set by the Engineer. The IX System Supplier change-out service shall include slurrying out the spent resin, profiling, disposing of the spent resin by incineration, and then replacing the vessel with virgin resin and switching the configuration of the lead and lag resin vessels.

B. All virgin resin shall be pre-rinsed at the IX System Supplier's facility to minimize onsite rinse water requirement. The resin will then be loaded in slurry trucks and transported to the site.

C. Spent resin, when removed from IX vessel, shall be removed from the project site and sent for

disposal no later than five (5) days after removal.

END OF SECTION

SPECIFICATION REVISION INDEX

Revision No.	Revision Date	Issued for	Signatures				
			Prepared By	Reviewed By	Project Engineer	Project Manager	Client
A	11/28/2016	60% Submittal	WX	JG	JG	STD	
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SECTION 11290

CYCLONES

TABLE 1: SUMMARY OF PROCESS PARAMETERS

Parameter	Units	Value
Average Flowrate	gpm	5,000
Maximum Flowrate	gpm	6,900
No. of cyclone vessels	Ea.	2
Average influent TSS concentration	ppm	50
Maximum influent TSS concentration	ppm	500
Minimum overflow backpressure	psi	80
Minimum underflow backpressure	psi	10
Maximum Operating Pressure	psi	200
Maximum Operating Temperature	°F	150
Minimum solids removal efficiency (at Specific Gravity = 2.0 and greater)	%	90

SECTION 11290

CYCLONES

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section describes materials, fabrication, and testing of a complete pre-engineered Cyclone System described herein for the removal of debris, suspended solids, dirt, and other particle matters from water produced during weir construction dewatering operation. The system shall be complete with cyclone vessels and liners, piping, valves and electric actuators, pressure transmitters and fittings.

B. The system supplied shall be capable of treating 6,900 gpm of influent flow at a maximum total suspended solids concentration of 500 ppm with all vessels online. The system shall achieve a minimum of 90% removal of solids equal to or larger than 10 microns with a specific gravity equal to or greater than 2.0.

1.1 RELATED SECTIONS

A. Section 01330—Shop Drawings, Product Data, and Samples

B. Section 01400 – Quality Control

C. Section 01600 – Common Product Requirements

D. Section 01630 – Product Options and Substitutions

E. Section 01730 – Operation and Maintenance Data

F. Section 01810 – Starting of Systems

G. Drawing I-501 – Cyclone HC-1 P&ID

H. Drawing I-502 – Cyclone HC-2 P&ID

I. Drawing I-802 – Cyclone Waste Tank P&ID

1.2 COORDINATION

A. The Cyclone Supplier will be responsible for providing and delivering equipment and appurtenances to the project site as specified herein.

B. The equipment shall be installed by the General Contractor, who will be responsible for off-loading the equipment, providing any temporary storage in accordance with the Supplier's recommendation for storage and installing the equipment in place.

1.3 WORK TO BE INCLUDED

A. The Cyclone Supplier shall be responsible for supplying the all system components needed to operate the cyclone per the specification, including, but not limited to, cyclone vessels and liners, all interconnecting piping, valves, control valves with electrical actuators, pressure transmitters and other instruments, interconnecting wiring and electrical connections, supports, anchors and all accessories required for a complete and working system. The Cyclone Supplier shall be responsible for the design, engineering, fabrication, factory testing and delivery to the site of all mechanical components. The Cyclone Supplier shall provide two (2) days of operator training and start-up at the site.

B. The skid-mounted Cyclone System as specified herein shall be comprised of:

1. At least two (2) cyclone vessels with 120 cyclone units in each vessel. The system shall have adequate capacity to operate at maximum influent flow and total suspended solids loading.
2. Interconnecting process and utility piping, wiring and electrical connections, valves and electrical actuators, pressure sensors/transmitters, and other accessories for each cyclone vessel necessary for the proper operation of the cyclone system.
3. One (1) pressure safety valve for each cyclone vessel.
4. One (1) complete set of technical specifications and plans and two (2) sets of operation and maintenance manuals.
5. Training of site operators by certified representative for two (2) days excluding travel time.

C. Work by Others

1. Unloading and staging of equipment
2. Reinforced concrete foundations
3. Setting and final anchoring of equipment to foundations
4. Influent raw wastewater line into the system
5. Overflow and underflow lines out of the system
6. Electrical power supply.
7. Controls and programming.

1.4 SUPPLIER'S QUALIFICATIONS

A. The Supplier of the Cyclone equipment shall have the following minimum qualifications:

1. Have previously designed, engineered and furnished cyclone treatment systems within the United States, designed for a minimum of 4,000-gpm total treatment capacity. Systems cited in experience submittals shall have similar configuration as the one to be proposed in this project.

2. Have furnished at least one (1) similar Cyclone system currently in use and removing suspended solids from the influent water stream. This system shall be designed to treat at least 4,000 gpm in total.

3. Provide three (3) references, with contact information, for systems described above.

1.5 WARRANTY

A. The Cyclone Supplier shall guarantee all equipment to be free of defects in material and workmanship for a period of 18 months from date of delivery of the equipment or 12 months from the date of final acceptance, whichever is longer.

1.6 CYCLONE SUPPLIER SERVICES

A. The Cyclone Supplier shall inspect all equipment upon delivery to the site and repair or replace damaged equipment. The Cyclone Supplier shall inform General Contractor and Engineer of delivery schedule and requirements for off-loading and staging of equipment.

B. All systems and components on cyclones must be pre-assembled and inspected free of defects at the Supplier's facility prior to delivery to site for installation.

C. The Cyclone Supplier shall provide one (1) full day of field services, excluding travel time, of qualified company personnel who will be responsible for pre-start-up inspection of the cyclone system, and site operator training (formal and informal), and assistance at the site during system start-up.

1.7 DESIGN CRITERIA

A. System Capacity – The Cyclone System shall be designed for a minimum flow of 2,000 gpm and a maximum flow rate of 6,900 gpm and according to the following water quality information (feed stream to the Cyclone System).

Parameter	Units	Value	
		Average	Maximum
Flow	gpm	5,000	6,900
Total Suspended Solids (TSS)	ppm	50	500
Specific Gravity of Water	-	1.0	1.0
Specific Gravity of Solids	-	2.0	> 2.0
Viscosity of Liquid	cP	1.0	1.2
Temperature	°F	55	68

B. The system shall achieve a minimum of 90% removal of solids equal to or larger than 10 microns having a specific gravity equal to or higher than 2.0.

C. The system shall have at least two (2) cyclones . The system shall have adequate capacity and flexibility to operate at both minimum and maximum influent flow and total suspended solids loading. The flow shall be distributed to the individual cyclone units so to optimize the performance of the cyclone system.

D. Cyclone supplier shall provide an operation schedule of the number of individual cyclone units in operation and the corresponding total flowrate.

E. Pressure Drop – Pressure drop across the system shall be limited to 40 – 55 psig.

F. Backpressure on underflow connection shall be no less than 10 psig, given that the backpressure on overflow is no less than 80 psig.

G. For the maximum total influent flow rate of 6,900 gpm, the design underflow rate shall be around 10 gpm out of the cyclone system.

H. System Design Pressure – Unless otherwise specified, cyclone vessels, piping, valves, and appurtenances subject to internal pressure during normal operation shall be designed, rated, and constructed for a working pressure of not less than 200 psig at 150°F.

1.8 MODES OF OPERATION

A. Cyclone Normal Operation – The cyclone system shall be designed with a continuous underflow removal system. Groundwater shall enter the cyclone vessels. Solids shall move downward along the vessel wall by centrifugal force and exit the vessel continuously at the bottom as the underflow stream. Liquid shall be reversed and move upward to exit the vessel as the overflow stream. The number of vessels and cyclone units in operation will be determined by the pressure drop across the system.

1.9 PERFORMANCE REQUIREMENTS

A. The system shall be designed to handle flow rates ranging from 2,000 gpm to 6,900 gpm with no adverse impact on performance. The system shall have adequate capacity to operate at maximum influent flow and total suspended solids loading.

B. The cyclones shall be designed to consistently remove at least 90% of solid particles equal to or larger than 10 microns with specific gravity equal to or larger than 2.0.

C. At the maximum total influent flow rate of 6,900 gpm and maximum influent TSS concentration of 500 ppm, the underflow flow rate must be no more than 10 gpm out of the cyclone system under design condition.

1.10 SUBMITTALS

A. Submit under provisions of 01330 – Shop Drawings, Product Data, and Samples.

B. Shop Drawings

1. Three (3) weeks after a Notice To Proceed from the Engineer, shop drawings including but not limited to, the following shall be delivered to the Engineer:

a. Project schedule indicating submittals, equipment delivery, installation, and start-up dates.

b. Flow schematic drawing indicating line sizes, valves, pressure sensors, method of support, utility (air, water, drain, electric) line sizes and connections.

c. Detailed simulation calculations for 50 ppm, 100 ppm, 200 ppm and 500 ppm TSS concentration (weight based) at influent flow rates of 2,300 gpm, 4,600 gpm, and 6,900 gpm. At minimum, the simulation calculations should include the following:
   1. Particle removal efficiency
   2. Overflow rate
   3. Underflow rate
   4. Overflow solids concentration
   5. Underflow solids concentration

d. Cyclone vessel shop or fabrication drawings with all dimensions indicated. Include identification and catalog cuts for purchases components and details for manufactured components. Identify materials, surface preparation, and finishes. Include calculations of wall thickness for cyclone vessel, manways and nozzles.

e. Pressure safety valve calculations

f. Applicable certifications and ratings.

g. Structural and seismic calculations for cyclone vessels. Calculations should be signed and approved by a Registered Professional Engineer within the State of Nevada. Engineer shall provide calculations for reactions at anchor bolts and selection of the size depth and number of bolts required for use with Simpson Set Epoxy anchor system.

h. Detailed drawings illustrating equipment arrangement, bill of materials, weights (dry and operating), size, and location of all anchor bolts and nuts, and plan view system drawing.

i. Piping arrangement drawings or plans and elevation drawings including details (i.e., flanged etc.) and location of all required connections to utilities and piping.

j. Three-dimensional (3D) models of equipment, piping and other appurtenances to be supplied, compatible for use in Revit or AutoCAD.

k. List of any extra materials or supplies provided.

l. List of recommended spare parts.

m. List of any special tools required.

n. Supplier's qualification as specified in Section C.

C. Operation and Maintenance Manual – After beginning fabrication of the treatment system and at least two (2) weeks prior to scheduled training, Cyclone Supplier shall submit two (2) copies of an operation and maintenance manual including:

1. Drawings, specifications, catalog cuts, and descriptive information on the products provided.

2. Instructions for operation and troubleshooting the system.

3. Control Narrative.

D. Cyclone Supplier's Installation Instructions – Prior to shipment of system components, Cyclone Supplier shall submit:

1. Instructions for the field personnel on handling and installation of the system for the Engineer's information.

2. Additional instructions, beyond the detailed drawings specified herein before, if needed, for the General Contractor's installation of utilities associated with the system and anchor bolts.

1.11 DELIVERY

A. The Cyclone Supplier shall familiarize themselves with site constraints and characteristics prior to shipment of system components. The Supplier shall provide the Engineer one week's notice and 24-hour confirmation of his intent to deliver the system.

PART 2 – MATERIALS

2.1 MANUFACTURERS

A. The system shall be manufactured by the Cyclone Supplier.

2.2 CYCLONE VESSELS

A. The pressure vessel shall be fabricated from carbon steel.

B. The liner plates shall be 316L stainless steel. The gaskets shall be Garlock 3510 or equal.

C. The maximum working pressure shall be no less than 200 psig at 150°F.

D. One (1) pressure safety valve shall be provided at each vessel to protect the vessel from overpressure.

2.3 VALVES

A. All isolation and control valves shall have a minimum Class 150 pressure rating.

B. Each cyclone vessel shall have six (6) electrically-actuated control valves for control, at the inlet and overflow outlet.

C. Isolation valves for each electrically-actuated valves, total twelve (12) per cyclone vessel.

D. One (1) slurry valve per vessel for underflow.

E. One (1) pressure safety valve per vessel.

2.4 INSTRUMENTATION

A. Two (2) pressure transmitters shall be provided for the Cyclone System, one (1) at the common inlet header and one (1) at the common outlet header from the Cyclones. System pressure reading from the transmitters shall be used to determine the pressure differential across the Cyclone System for operating control.

PART 3 – EXECUTION

3.1 INSTALLATION (NOT USED)

3.2 TESTING AND START-UP (NOT USED)

END OF SECTION

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SPECIFICATION REVISION INDEX

Revision No.	Revision Date	Issued for	Signatures				
			Prepared By	Reviewed By	Project Engineer	Project Manager	Client
A	11/28/2016	60% Submittal	WX	JG	JG	STD	
B	1/27/2017	DRAFT 90% Submittal	WX	JG	JG	STD	
C	2/15/2017	75% Submittal	WX	JG	JG	STD	

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SECTION 11295

END SUCTION CENTRIFUGAL PUMPS

PART 1 - GENERAL

1.1 DESCRIPTION

A. The Pump Supplier shall provide all end-suction centrifugal pumps listed below, along with installation and start-up support, and operations and maintenance (O&M) manuals for the pumps as specified herein.

1. Sunrise Mountain Weir Site Transfer Pumps (PU-1A/B/C)
   a. These pumps transfer water from the Sunrise Mountain Weir Construction Site to the Central Water Treatment Plant.

2. Historic Lateral Weir Site Transfer Pumps (PU-2A/B/C + 1 shelf spare)
   a. These pumps transfer water from the Historic Lateral Weir Construction Site to the Central Water Treatment Plant.

3. Treated Water Discharge Pumps (PU-6A/B/C/D)
   a. These pumps discharge treated water from the Treated Water Tanks (TK-4A/B/C) within the Central Water Treatment Plant to the Las Vegas Wash for final discharge.

4. Filter Rinse/Backwash Pumps (PU-5A/B/C)
   a. These pumps supply treated water from the Treated Water Tanks (TK-4A/B/C) to the Multi-Media Filters (MMF-1A/B/C) at the Central Water Treatment Plant for rinsing and backwashing.

1.2 RELATED SECTIONS

A. Section 01330 – Shop Drawings, Product Data, and Samples

B. Section 01400 – Quality Control

C. Section 01600 – Common Product Requirements

D. Section 01630 – Product Options and Substitutions

E. Section 01730 – Operation and Maintenance Data

1.3 COORDINATION

A. The Pump Supplier will be responsible for providing and delivering pumps and appurtenances to the project site as specified herein.

B. The equipment shall be installed by General Contractor, who will be responsible for off-loading the equipment, providing any temporary storage in accordance with the Supplier's recommendation for storage and installing the equipment in place. Installation will include mounting the pumps and provide interconnecting piping, power and all interconnected wiring and controls.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include materials of construction, rated capacities, certified performance curves with operating points plotted on curves, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Submittals shall comply with Section 01300 – Shop Drawings.

C. Three-dimensional (3D) models of equipment, piping and other appurtenances to be supplied, compatible for use in Revit or AutoCAD.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For all pumps include operation and maintenance manuals.

B. Operation and maintenance manuals shall comply with Section 01730 – Operations & Maintenance Data.

1.6 DESIGN CONDITIONS

A. Sunrise Mountain Weir Site Transfer Pump

1.	Process	Groundwater with up to 100 ppm Total Suspended Solids (TSS)
2.	Flow Rate	2,300 gpm
3.	TDH at Duty Point	360 ft.
4.	Speed	3,540 rpm
5.	No. of Stages	1
6.	Motor HP	300 (350 HP Motor Rated to 300 HP)
7.	Pump Efficiency at Design Point	80%
8.	Manufacturer	Flowserve or Peerless or approved equal
9.	Model	6HPX12C FPD- S-6 or 8TU16G2 approved equal
10.	Number of Pumps	3
11.	Location	Outdoor
12.	Maximum Motor Start/Stop Frequency	6 times/hour
13.	Maximum Ambient Temperature	110°F

B. Historic Lateral Weir Site Transfer Pump

1.	Process	Groundwater with up to 100 ppm TSS

2.	Flow Rate	2,300 gpm
3.	TDH at Duty Point	460 ft.
4.	Speed	3,540 rpm
5.	No. of Stages	1
6.	Motor HP	350 (400 HP Motor Rated to 350 HP)
7.	Pump Efficiency at Design Point	80%
8.	Manufacturer	Flowserve or Peerless or approved equal
9.	Model	6HPX12C FPD-S-6 or approved equal
10.	Number of Pumps	4, including a spare pump
11.	Location	Outdoor
12.	Maximum Motor Start/Stop Frequency	6 times/hour

C. Treated Water Discharge Pump

1.	Process	Treated water containing less than 5 ppm TSS and 4.0 ppb perchlorate
2.	Flow Rate	2,300 gpm
3.	TDH at Duty Point	23.1 ft.
4.	Speed	960 rpm
5.	No. of Stages	1
6.	Motor HP	20
7.	Maximum Motor Start/Stop Frequency	6 times/hour
8.	Pump Efficiency at Design Point	84%
9.	Manufacturer	Flowserve or Peerless or approved equal
10.	Model	3K10x8-14RV M3 ST FPD or 10AE14J or approved equal
11.	Number of Pumps	4, includes a spare
12.	Location	Outdoor
13.	Maximum Ambient Temperature	110°F

D. Filter Rinse/Backwash Pump

1.	Process	Treated water containing less than 5 ppm TSS and 4.0 ppb perchlorate
2.	Flow Rate	1,500 gpm
3.	TDH at Duty Point	92.4 ft.
4.	Speed	1,180 rpm
5.	No. of Stages	1
6.	Motor HP	50
7.	Maximum Motor Start/Stop Frequency	6 times/hour
8.	Pump Efficiency at Design Point	80%
9.	Manufacturer	Flowserve or Peerless or approved equal
10.	Model	3K8x6-16ARVM3ST/1 or approved equal
11.	Number of Pumps	3, includes a spare
12.	Location	Outdoor
13.	Maximum Ambient Temperature	110°F

1.7 QUALITY ASSURANCE

A. End suction centrifugal pumps must be manufactured at an ISO9000 rated facility. All Pumps must be furnished complete by the Pump Supplier. This includes the shafting, seals, discharge heads, couplings, and motors. Pumps shall be manufactured by Flowserve or approved equal.

1.8 WARRANTY

A. The Pumps furnished per this specification shall be guaranteed by the manufacturer and administered by the selling dealer against defects in material or workmanship for a period of one (1) year from date of final acceptance of the project. It shall cover parts and labor and be administered per the Supplier's standard extended warranty. This factory warranty shall cover all the aforementioned equipment specified in the Contract Documents.

PART 2 - PRODUCTS

2.1 MATERIALS

A. All materials employed in the pumping equipment shall be suitable for the intended application; material not specifically called for shall be high-grade, standard commercial quality, free from all defects and imperfection that might affect the serviceability of the product for the purpose for which it is intended, and shall conform to the following requirements:

1. Cast iron pump casings shall be of close-grained gray cast iron, conforming to ASTM A 48, or equal.

2. Bronze pump impellers shall conform to ASTM B 62.

3. Stainless steel pump shafts shall be of Type 400 Series. Miscellaneous stainless steel parts shall be Type 316 except in septic environment.

2.2 PUMPING APPURTENANCES

A. Each pump shall be equipped with a stainless steel nameplate indicating rated head and flow, impeller size, pump speed, the year of manufacture, and manufacturer's name and model number.

2.3 PUMP REQUIREMENTS – GENERAL

A. Suction and discharge flanges shall conform to ANSI Standard B16.1 or B16.5 dimensions.

B. All gland seals, air valves, and cooling water drains shall be piped to the nearest floor sink, or drain, with red brass pipe properly supported with brackets.

C. Mechanical seal designs shall be selected for highest reliability and for rugged service. Mechanical seals shall be provided using lantern rings. Unless the pump manufacturer recommends a better seal for specific application, the following mechanical seals shall be furnished with the pumps:

Clean Water Pumps	Single Seals: John Crane, Type 1, 21

D. Preferred seals for all services other than chemicals and corrosive shall be equipped with nonclogging, single coil springs, and nonsliding, internal, secondary elastomers. Metal parts shall be of 300 series, corrosion-resistant materials.

2.4. PUMP DISCHARGE HEADS

A. The discharge of pump shall be Fabricated Steel. The top of each discharge head shall have a machined register to mount the driver and ensure proper shaft alignment. The stuffing box shall be fitted with a packing container designed for the pump maximum pressure including shut-off. The discharge heads shall have an above base outlet sized for standard pipe, faced and drilled for a 150 lb, companion flange. The mounting base of the discharge heads shall be machined flat. A machined register shall be provided on the bottom of the discharge heads and shall be fitted with a top flange of sufficient strength to adequately secure the weight of the water being pumped.

B. Unless otherwise noted, all nuts and bolts for the pump discharge heads shall be stainless steel.

2.5 EXTRA MATERIALS / SPARE PARTS

A. Special Tools Required – Provide one (1) set of any special tools required to maintain equipment furnished under this Section.

B. Provide all spare parts that are likely to be required within the first year of operation plus all Supplier's recommended spare parts.

2.6 GUARANTEED PERFORMANCE

A. Pump Supplier shall submit a published pump curve showing the guaranteed efficiency of the pump operating at the design point. This curve shall be CERTIFIED BY THE MANUFACTURER not a distributor, agent or representative of the pump manufacturer. All pump materials including the shafting, seals strainers, and all other materials, must be supplied by the pump manufacturer as a complete pump.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Pump Supplier shall provide the services of a factory trained Service Technician during the installation of the equipment covered by this specification. These services are not supervisory; but are advisory only, to ensure that the unit is installed and operating per the manufacture's design. For the installation to be accepted, the Service Technician will certify that the unit is

installed per Supplier's design.

3.2 START-UP AND TESTING

A. All pumps shall be factory-tested prior to delivery to the Site.

B. Pump Supplier shall provide the services of a factory-trained Service Technician to assist in the start-up of the equipment and train personnel in the operation and maintenance of the equipment. Pump Supplier shall provide training to Engineer's representative after equipment startup.

C. Performance Testing (Not Used)

END OF SECTION

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SECTION 11315

PROGRESSING CAVITY PUMPS

PART 1 - GENERAL

1.1 DESCRIPTION

A. The Pump Supplier shall provide all progressing cavity pumps listed below, with horizontal electric motors and bases, along with installation and start-up support, and operations and maintenance (O&M) manuals for the pumps as specified herein. Pumps shall be mounted on a skid complete with all accessories.

1. Cyclone Waste Transfer Pumps (PU-4A/B)
   a. These pumps transfer underflow solids from the Cyclone Waste Tank (TK-5) to the Backwash Waste Tanks (TK-3A/B) or for truck out.

1.2 RELATED SECTIONS

A. Section 01330 – Shop Drawings, Product Data, and Samples

B. Section 01400 – Quality Control

C. Section 01600 – Common Product Requirements

D. Section 01630 – Product Options and Substitutions

E. Section 01730 – Operation and Maintenance Data

F. Drawing I-804 – Cyclone & Backwash Waste Pumps P&ID

1.3 COORDINATION

A. The Pump Supplier will be responsible for providing and delivering pumps and appurtenances to the project site as specified herein.

B. The equipment shall be installed by General Contractor, who will be responsible for off-loading the equipment, providing any temporary storage in accordance with the Supplier's recommendation for storage and installing the equipment in place. Installation will include mounting the pumps and provide interconnecting piping, power and all interconnected wiring and controls.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include materials of construction, rated capacities, certified performance curves with operating points plotted on curves, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Submittals shall comply with Section 01300 – Shop Drawings.

C. Three-dimensional (3D) models of equipment, piping and other appurtenances to be supplied, compatible for use in Revit or AutoCAD.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For all pumps include operation and maintenance manuals.

B. Operation and maintenance manuals shall comply with Section 01730 – Operations & Maintenance Data.

1.6 DESIGN CONDITIONS

A. Cyclone Waste Transfer Pump

1.	Process	Cyclone waste containing up to 10% suspended solids
2.	Flow Rate	30 gpm
3.	Discharge Pressure	69 ft.
4.	Motor HP	3
5.	Suction	Flooded
6.	Manufacturer	Seepex or Equal
7.	Model	BN 10-6L or equal
8.	Number of Pumps	2, including a spare
9.	Location	Outdoor
10.	Maximum Ambient Temperature	110°F

1.7 QUALITY ASSURANCE

A. Progressing cavity pumps must be manufactured at an ISO9000 rated facility. All pumps must be furnished complete by the Pump Manufacturer. This includes the shafting, seals, discharge heads, couplings, and motors. Pumps shall be manufactured by Seepex or approved equal.

1.8 WARRANTY

A. The Pumps furnished under this Contract Document shall be guaranteed by the manufacturer and administered by the selling dealer against defects in material or workmanship for a period of one (1) year from date of final acceptance of the project. It shall cover parts and labor and be administered per the manufacturer's standard extended warranty. This factory warranty shall cover all the aforementioned equipment specified in the Contract Documents.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Construction of the progressing cavity pump shall conform to the following requirements.

1. Pump body (with hand hole): cast iron
2. Stator: Elastomer Buna N
3. Rotor: Stainless steel
4. Seal: Gland packing
5. Bearings: Ball and tapered roller bearings, 60,000 hours. B-10 life.
6. Low flow cut-off switch: Manufacturer's standard to protect pump.
7. Pump Base: Steel base with pan and drain.

B. Pump Drive: Gear drive with electrical variable speed drive with horizontal, heavy duty, variable-speed electric motor, suitable for 460 V, 3 phase, 60 HZ AC power supply.

C. Two (2) progressing-cavity pumps shall be mounted on a skid conforming to the following:

1. Pump skid: Painted carbon steel skid
2. Suction and Discharge Piping: Carbon steel
3. Suction and Discharge Pressure Gauges:
4. Variable frequency drives (VFDs) with NEMA 3 Enclosure.
5. Includes all interconnecting wiring and conduit to VFDs
6. Combined inlet and outlet piping, valves, instruments and other accessories outside of the skid shall be provided by others.

2.2 MOTOR:

A. The motor shall be 3.0 HP. The pump motor shall be of suitable design for the specified operating conditions with the highest power requirement not exceeding 3.0 HP.

B. Pump shall be direct driven through gear drive.

C. Motor shall be in current NEMA design cast iron frame with copper windings.

D. Motor shall be mounted on a common base plate with the pump.

E. Motor shall be inverter-duty suitable for operating on VFD.

2.3 EXTRA MATERIALS / SPARE PARTS

A. Special Tools Required – Provide one (1) set of any special tools required to maintain equipment furnished under this Section.

B. Provide all spare parts that are likely to be required within the first year of operation plus all Supplier's recommended spare parts.

2.4 PUMPING APPURTENANCES

A. Each pump shall be equipped with a stainless steel nameplate indicating rated head and flow, pump speed, the year of manufacture, and manufacturer's name and model number.

2.5 GUARANTEED PERFORMANCE

A. Pump Supplier shall submit a published pump curve showing the guaranteed efficiency of the pump operating at the design point. This curve shall be CERTIFIED BY THE MANUFACTURER NOT a distributor, agent or representative of the pump manufacturer. All pump materials including the shafting, seals strainers, and all other materials, must be supplied by the pump manufacturer as a complete pump.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Pump Supplier shall provide the services of a factory-trained Service Technician during the installation of the equipment covered by this specification. These services are not supervisory; but are advisory only, to ensure that the unit is installed and operating per the Supplier's design. For the installation to be accepted, the Service Technician will certify that the unit is installed per Supplier's design.

3.2 START-UP AND TESTING

A. All pumps shall be factory-tested prior to delivery to the Site.

B. Pump Supplier shall provide the services of a factory-trained Service Technician to assist in the start-up of the equipment and train personnel in the operation and maintenance of the equipment. Pump Supplier shall provide training to Engineer's representative after equipment startup.

C. Performance Testing (Not Used)

END OF SECTION

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SECTION 13209

STEEL WATER STORAGE TANKS

PART 1 GENERAL

1.1 SUMMARY

A. The Tank Supplier shall provide baker-style steel tanks are specified herein:
   1. Sunrise Mountain Pump Station Influent Tanks (TK-1A/B/C/D)
      a. These tanks collect raw water from groundwater extraction wells at the Sunrise Mountain Weir Site at the Las Vegas Wash to be pumped to the Central Water Treatment Plant.
   2. Historic Lateral Pump Station Influent Tanks (TK-2A/B/C/D)
      a. These tanks collect raw water from groundwater extraction wells at the Historic Lateral Weir Site at the Las Vegas Wash to be pumped to the Central Water Treatment Plant.
   3. Rinse Water Transfer Tank (TK-6)
      a. These tanks collect rinsed water from Multi-Media Filter System to be transferred to the Ion-Exchange System.
   4. Treated Water Tanks (TK-4A/B/C/D)
      a. These tanks collect treated water from the Central Water Treatment Plant prior to discharge to the Las Vegas Wash.

B. Tanks shall be leased by Engineer. The General Contractor shall set the tanks at the Sunrise Pump Station, Historic Lateral Pump Station and the Central Water Treatment Plant, provide interconnecting piping, power and all interconnected wiring and controls.

1.2 DEFINITIONS

A. Tank Low Level: Level when emptied through specified discharge fittings unless otherwise indicated on Drawings.

1.3 SUBMITTALS

A. Product Data:
   1. Expansion joint fittings and other pipe specialty fittings.
   2. Ladder and ladder safety devices.
   3. Materials of construction, fabrication, and coatings.

B. Shop Drawings:
   1. Complete plan, elevation, and sectional Drawings showing critical dimensions.
   2. Detailed nozzle schedule.
   3. Ladder and ladder safety device details.
   4. Handrail details.
   5. Access hatch details.
   6. Any other appurtenances.

C. Supplier's Certificate: Certify that tanks and appurtenances meet or exceed specified requirements.

D. Delegated Design Submittals: Submit signed and sealed Shop Drawings with design calculations and assumptions for tank structural calculations.

E. Test and Evaluation Reports:
   1. Submit mill test reports.
   2. Written Report Certifying Work: Prepare and submit as indicated in AWWA D103.
   3. Submit Installation Certificate from equipment manufacturer's representative as described in PART 3.

F. Supplier Instructions: Installation requirements, including tank component handling procedures, anchoring, and layout.

G. Source Quality-Control Submittals: Indicate results of shop tests and inspections.

H. Field Quality-Control Submittals: Indicate results of General Contractor-furnished tests and inspections.

I. Qualifications Statements:
   1. Qualifications for Supplier.

1.4 COORDINATION

A. The Tank Supplier will be responsible for providing and delivering tanks and appurtenances to the project site as specified herein.

B. The equipment shall be installed by General Contractor, who will be responsible for off-loading the equipment, providing any temporary storage in accordance with the Supplier’s recommendation for storage and installing the equipment in place. Installation will include setting the tanks provide interconnecting piping, power and all interconnected wiring and controls.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual location and orientation of tank and appurtenances.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Materials:
   1. Two safety harnesses for ladder safety rail system.

1.7 QUALITY ASSURANCE

A. Perform Work according to AWWA D103.

B. Perform Work according to <_____> standards.

C. Supplier: Company specializing in the supply of products specified in this Section with three years' experience.

D. General Contractor: Company specializing in performing Work of this Section with three years' experience.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Storage:
   1. Store materials in areas protected from weather and moisture and according to Supplier instructions.
   2. Do not store products directly on ground.

B. Handling: Handle materials in a manner to prevent damage to interior or exterior surfaces.

C. Protection:
   1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
   2. Provide additional protection according to Supplier instructions.

1.9 EXISTING CONDITIONS

A. Field Measurements:
   1. Verify field measurements prior to fabrication.
   2. Indicate field measurements on Shop Drawings.

1.10 WARRANTY

A. Furnish five year Supplier's warranty for bolted steel tanks.

PART 2 PRODUCTS

2.1 TANKS

A. Suppliers:
   1. Baker Corp.
   2. Rain for Rent
   3. Other approved equals.

B. Description:
   Design, fabricate, deliver and erect thirteen (13) 20,100-gallon ground-level, Baker Style steel tank and accessories, identical or similar to Baker Corp’s “Fixed Axle Tank 500 bbl Round Bottom Modern” tank.

C. Performance and Design Criteria:
   1. Requirements as listed in AWWA D103, unless supplemented or modified in this Section:
      a. Bottom capacity level (BCL) and top capacity level (TCL) above top of foundation.
      b. Roof and Bottom: As indicated.

c. Head Range: 15 feet.
d. Location of Site: As indicated.
e. Snow Loading:
    1) Comply with AWWA D103, Section 5.2.3.1.
f. Wind Loading:
    1) Comply with AWWA D103, Section 5.2.4.
g. Earthquake Loading: Comply with AWWA D103, Section 5.2.5.

2.2 TANK CONSTRUCTION

A. Comply with requirements listed in AWWA D103, unless supplemented or modified below:
    1. Pipe and Fittings for Fluid Conductors: Modify to indicate only welded joints for conductors are acceptable.
    2. Roof Deck: ¼" thick ASTM A36 carbon steel
    3. Roof Frame: 3" wide X 1.5" tall channel shaped steel (on exterior side of roof deck)
    4. Vent connection: 4" flanged nozzle with blind and Buna-N gasket.
    5. Safety Devices:
        a. Furnish safety rail along entire ladder length and extending <_48_____> inches (<_____> mm) above tank roof.
        b. Comply with OSHA standards.
    6. Manways: 21.5" diameter top, front and side manways with Buna-N gasket.
    7. Stairway: Front mounted with access from driver's side of the tank.
        a. Level Gauge

2.3 TANK CONNECTIONS, NOZZELS AND MANWAYS

A. The tank shall be equipped with at least one (1) 150 Class 8" or lager flanged nozzle at the bottom of the tank serving as the outlet connection for the tank.

B. At least one (1) manway shall be provided on the tank roof, one (1) of the side walls and one (1) of the end walls respectively, and at least one (1) of the side/end wall manway lids shall be modified with One (1) 150 Class 12" flanged nozzle serving as the inlet of the tank.

C. The tank shall be equipped with at least two (2) 3" or 4" nozzles on the top of the tank suitable for ultrasonic level transmitter installation.

D. The tank shall be equipped with at least one (1) 150 Class flanged connection with butterfly valve for the tank drain.

2.4 MATERIALS

A. Furnish materials complying with this Section, as indicated, and according to AWWA D103.

2.5 FABRICATION

A. Materials, Design, and Fabrication: According to AWWA D103.

2.6 SOURCE QUALITY CONTROL

A. Provide shop inspection and testing of component parts.

B. Certificate of Compliance:
   1. If fabricator is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at fabricator's facility conforms to Contract Documents.
   2. Specified shop tests are not required for Work performed by approved fabricator.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify layout and orientation of tank accessories and piping connections.

3.2 PREPARATION

A. Support Pad:
   1. Clean tank pad, removing loose concrete, dust, and other debris.
   2. Place building paper on pad according to Tank Supplier's recommendations prior to placing tank.

3.3 INSTALLATION

A. According to Supplier instructions.

B. Connect piping to tank.

C. To complete installation, install tank accessories not factory mounted.

D. Touch-up Painting and Coating: According to Supplier instructions.

3.4 FIELD QUALITY CONTROL

A. Inspection and Testing:
   1. Hydrostatic Testing:
      a. Test completed and cleaned tank for liquid tightness by filling tank to its overflow elevation with water provided by Engineer.
      b. Correct leaks disclosed by this test.
      c. Drain and legally dispose of test water off Site.

B. Equipment Acceptance: Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.

C. Furnish installation certificate from Supplier's representative attesting that equipment has been properly installed and is ready for startup and testing.

3.5 ATTACHMENTS

A. Schedules: <_____>.

B. Tables: <_____>.

C. Illustrations: <_____>.

D. Forms: <_____>.

END OF SECTION

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SECTION 13218

STEEL MIXING TANKS

PART 1 GENERAL

1.1 SUMMARY

A. The Tank Supplier shall provide baker-style steel mixing tanks specified herein:
   1. Backwash Waste Tanks (TK-3A/B)
      a. These tanks collects backwash waste from Multi-Media Filter System (with up to 0.5% suspended solids) and solids from the Cyclone Waste Tank for blending with the Treated Water out of the Treated Water Tanks.
   2. Cyclone Waste Tank (TK-5)
      a. These tanks collect underflow solids (up to 10% solids) from the Cyclones for either off-site disposal or discharge to the Backwash Waste Tank.

B. Tanks shall be leased by Engineer. The General Contractor shall set the tanks at the Central Water Treatment Plant, provide interconnecting piping, power and all interconnected wiring and controls.

1.2 DEFINITIONS

A. Tank Low Level: Level when emptied through specified discharge fittings unless otherwise indicated on Drawings.

1.3 SUBMITTALS

A. Product Data:
   1. Mechanical mixers and electrical motors with controls
   2. Expansion joint fittings and other pipe specialty fittings.
   3. Ladder and ladder safety devices.
   4. Materials of construction, fabrication, and coatings.

B. Shop Drawings:
   1. Complete plan, elevation, and sectional Drawings showing critical dimensions.
   2. Detailed nozzle schedule.
   3. Electrical single line diagram and control panels.
   4. Structural plate and support member sizes and thickness.
   5. Weld types and sizes.
   6. Mixer and motor information
   7. Water supply and overflow piping details, including fittings, expansion joints, pipe support methods, and accessories.
   8. Ladder and ladder safety device details.
   9. Handrail details.
   10. Access hatch details.
   11. Any other appurtenances.

C. Supplier's Certificate: Certify that tanks and appurtenances meet or exceed specified requirements.

D. Delegated Design Submittals: Submit signed and sealed Shop Drawings with design calculations and assumptions for tank structural calculations.

E. Test and Evaluation Reports:
   1. Submit mill test reports.
   2. Written Report Certifying Work: Prepare and submit as indicated in AWWA D103.
   3. Submit Installation Certificate from equipment manufacturer's representative as described in PART 3.

F. Supplier Instructions: Installation requirements, including tank component handling procedures, anchoring, and layout.

G. Source Quality-Control Submittals: Indicate results of shop tests and inspections.

H. Field Quality-Control Submittals: Indicate results of General Contractor-furnished tests and inspections.

I. Qualifications Statements:
   1. Qualifications for Supplier.

1.4 COORDINATION

A. The Tank Supplier will be responsible for providing and delivering tanks and appurtenances to the project site as specified herein.

B. The equipment shall be installed by General Contractor, who will be responsible for off-loading the equipment, providing any temporary storage in accordance with the Supplier’s recommendation for storage and installing the equipment in place. Installation will include setting the tanks provide interconnecting piping, power and all interconnected wiring and controls.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual location and orientation of tank and appurtenances.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Materials:
   1. Two safety harnesses for ladder safety rail system.

1.7 QUALITY ASSURANCE

A. Perform Work according to AWWA D103.

B. Materials in Contact with Potable Water: Certified to NSF Standards 61 and 372.

C. Perform Work according to <_____> standards.

D. Supplier: Company specializing in the supply of products specified in this Section with three years' experience.

E. General Contractor: Company specializing in performing Work of this Section with three years' experience.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Storage:
   1. Store materials in areas protected from weather and moisture and according to Supplier instructions.
   2. Do not store products directly on ground.

B. Handling: Handle materials in a manner to prevent damage to interior or exterior surfaces.

C. Protection:
   1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
   2. Provide additional protection according to Supplier instructions.

1.9 EXISTING CONDITIONS

A. Field Measurements:
   1. Verify field measurements prior to fabrication.
   2. Indicate field measurements on Shop Drawings.

1.10 WARRANTY

A. Furnish five year Supplier's warranty for bolted steel tanks.

PART 2 PRODUCTS

2.1 TANKS

A. Suppliers:
   1. Baker Corp.
   2. Rain for Rent
   3. Other approved equals.

B. Description:
   1. Design, fabricate, and erect three (3) 17,850-gallon ground-level, mixer equipped, steel tank and accessories identical or similar to Baker Corp’s 425 bbl “Baker Mix Tank”.

C. Performance and Design Criteria:
   1. Requirements as listed in AWWA D103, unless supplemented or modified in this Section:
      a. Bottom capacity level (BCL) and top capacity level (TCL) above top of foundation.

b. Roof and Bottom: As indicated.
c. Head Range: 13 feet.

2.2 TANK CONSTRUCTION

A. Comply with requirements listed in AWWA D103, unless supplemented or modified below:

1. Floor: ¼" thick ASTM A36 carbon steel (flat bottom)

2. Sides/Ends: ¼" thick ASTM A36 carbon steel

3. Roof deck: ¼" thick ASTM A36 carbon steel

4. Roof frame: 4" steel channel

5. Manways:

6. Stairways: Exterior stairways towards the rear end of the tank

7. Total Drain: 4" 150# flanged nozzle and butterfly valve, front end, curb side

2.3 MIXERS

A. Each tank shall be equipped with four submersible type mechanical mixers. The mixers shall be capable of handling slurries with up to 10% suspended solids.

B. Electric motors: Four (4) 10-hp, 215 frame, 480 volts, 60 Hz 3 phase with EPFC enclosure 40 deg. C. Power shall be provided by others.

C. Gearboxes: SEW Eurodrive type KF87 with a reduction ratio of 25:1

D. Mixer shafts: Two (2) 118' long X 2-3/8" diameter steel shafts and two (2) 79" long X 2-3/8" diameter steel shafts

E. Mixer Blades: One set of four long blades (3/8"X6"X18") and one set of four short blades (3/8"X6"X10")

F. Heating coils: Four-pass 3" Sch.80 serpentine pipe (3" 150# flanges) or multi-pass 2" Sch. 40 header style

2.4 TANK CONNECTIONS, NOZZELS AND ROOF DOORS/MANWAYS

A. The tank shall be equipped with at least one (1) 150 Class 4" or lager flanged nozzle at the bottom of the tank serving as the outlet connection for the tank.

B. At least one (1) manway or roof door shall be provided on the tank roof. This manway or roof door may serve as the inlet of the tank.

C. The tank shall be equipped with at least two (2) 3" or 4" nozzles on the top of the tank suitable for ultrasonic level transmitter installation.

D. The tank shall be equipped with at least one (1) 150 Class 4" flanged connection for the tank drain.

2.5 MATERIALS

A. Furnish materials complying with this Section, as indicated, and according to AWWA D103.

2.6 FABRICATION

A. Materials, Design, and Fabrication: According to AWWA D103.

2.7 SOURCE QUALITY CONTROL

A. Provide shop inspection and testing of component parts.

B. Certificate of Compliance:
   1. If fabricator is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at fabricator's facility conforms to Contract Documents.
   2. Specified shop tests are not required for Work performed by approved fabricator.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify layout and orientation of tank accessories and piping connections.

3.2 PREPARATION

A. Support Pad:
   1. Clean tank pad, removing loose concrete, dust, and other debris.
   2. Place building paper on pad according to Tank Supplier's recommendations prior to placing tank.

3.3 INSTALLATION

A. According to Supplier instructions.

B. Connect piping to tank.

C. To complete installation, install tank accessories not factory mounted.

D. Touch-up Painting and Coating: According to Supplier instructions.

3.4 FIELD QUALITY CONTROL

A. Inspection and Testing:

1. Hydrostatic Testing:
    a. Test completed and cleaned tank for liquid tightness by filling tank to its overflow elevation with water provided by Engineer.
    b. Correct leaks disclosed by this test.
    c. Drain and legally dispose of test water off Site.
2. Electrical checks and air pressure test of coil as needed.

B. Equipment Acceptance: Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.

C. Furnish installation certificate from Supplier's representative attesting that equipment has been properly installed and is ready for startup and testing.

3.5 ATTACHMENTS

A. Schedules: <_____>.

B. Tables: <_____>.

C. Illustrations: <_____>.

D. Forms: <_____>.

END OF SECTION

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SPECIFICATION REVISION INDEX

Revision No.	Revision Date	Issued for	Signatures				
			Prepared By	Reviewed By	Project Engineer	Project Manager	Client
A	11/28/2016	60% Submittal			JG	STD	
B	1/27/2017	DRAFT 90% Submittal			JG	STD	
C	2/15/2017	75% Submittal			JG	STD	

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SECTION 13410

BASIC INSTRUMENTATION REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: General administrative and procedural requirements for instrumentation, monitoring and control installations. Administrative and procedural requirements are included in this Section to expand on requirements specified in Division 1. This section shall apply to all systems including pre-engineered systems.

B. This section describes the requirements for furnishing, installing, testing, and placing into operation plant control systems and components. Provide the detailed hardware configuration, manufacture, program configuration, test, startup, installation assistance, and demonstration of equipment. Although not all requirements are defined herein, the major elements of the work include the following:

1. Furnish and install a CompactLogixAllen BradleyAllen Bradley PLC based monitoring and control system consisting of master and remote PLCs, controllers, graphics for operator interface, paging, historical data collection and storage, and report production as defined in these contract documents.

2. Provide configuration and application programming as specified in section 13700 – Process Control Software Programming for new and existing equipment.

3. Furnish and install control panels and panel instrumentation as required.

4. Furnish and install plant field instrumentation as defined elsewhere.

5. Configure all sensors, analytics, controllers, drives, etc.

6. Furnish, for installation by mechanical process solenoid valves and actuated valves.

C. The CONSTRUCTION MANAGER will have an operator or technician available on demand, Monday through Friday, up to 8 hours per day with 2 hours notice, during startup.

D. The Systems Integrator will attend at least 4 progress meetings at the job site during startup. System Integrator shall be responsible for providing all SCADA hardware and instrumentation not integral to a pre-engineered system. Integrator shall coordinate with pre-engineered system vendors to insure compatibility with the SCADA system. Vendors shall provide panel PLC logic for troubleshooting and integration purposes.

E. System integrator shall have at least 5 years experience with Allen BradleyAllen Bradley CompactLogix and RSLogix5000 and 5 years experience with VTScada.

1.02 SUBMITTALS

A. Shop Drawings: Submit in accordance with Division 1, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:

1. Product data for each product specified.

2. Wiring diagrams, both elementary and schematic, differentiating between manufacturer installed and field-installed wiring.

3. Digital Systems: Provide the following:

a. Digital equipment layouts of input and output racks showing complete module model number and addressing assignment. Layouts of port pin assignment, connection schematic indicating cable types and port addresses.

4. Software Programs: One fully annotated printed copy of program prior to factory test. In addition, provide required number of copies of latest revisions of program at time of acceptance by CONSTRUCTION MANAGER. Submittal of printouts, listings, and screen images shall be supplied on paper (hard copy). With concurrence of CONSTRUCTION MANAGER, electronic copies may be supplied in addition to printed copies as a matter of convenience. Format of media shall be as mutually agreed with CONSTRUCTION MANAGER. Provide electronic logic files, program files, data files, etc. in their uncompiled states to support future changes by the end user without integrator’s assistance.

5. Programmable Logic Controllers: Submits lists of input and output assignments, data file structures used, tags, and internal data points. Show points used to communicate between PLCs, the operator interface and data collection segments. Include complete, fully annotated ladder logic diagrams complete with cross-reference listings.

6. Operator Interface and Supervisory Control: Submit "screen dump" images of each proposed operator interface and SCADA HMI screen. Describe color schema, mouse button use, function key controls and communication protocol with PLCs. Provide a flow diagram showing screen navigation. Show sample event and alarm log outputs.

7. Data Collection: Submit details of data structures, communications protocols, data exchange formats, sampling intervals, and file storage space management. Provide "screen dump" images of historical trending.

8. Data Management and Reporting: Includes process data management, laboratory management, and reporting. Submit data definitions, customization of base

software, data entry screens, menus, and report formats. Describe data entry, collection, and reporting scenarios. Describe data file storage management including backup and archive operations.

B. Record Drawings: At Project closeout, submit record drawings of installed products, in accordance with requirements of Division 1.

1. Where Drawings are drafted by computer equipment, CONSTRUCTION MANAGER shall furnish files on a disk. These Drawings shall include changes made by Field Orders, Change Orders, Addenda, and errors discovered during start-up and acceptance.

2. Drawings shall include terminal numbers at each wiring termination and piping termination. A complete system diagram shall be included.

C. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01730, Operating and Maintenance Data, for items included under this Section.

1. Instructions shall be short, easy-to-understand directions specifically written for this Project describing various possible methods of operating equipment. Instructions shall include procedures for tests required, adjustments to be made, and safety precautions to be taken with equipment. These documents are to be submitted to CONSTRUCTION MANAGER'S office.

2. Provide 4 complete set of manufacturer's documentation covering programmable equipment supplied. Include hardware manuals and prints as manufacturer normally ships with programmable equipment. One copy shall be an electronic copy on CD.

a. Include complete software manuals for operating system, as well as manuals for any other software. Written instructions for the operations and maintenance of software shall be provided. The instructions shall be short, easy-to-understand directions specifically written for this Project describing various possible methods of operating software.

b. Include program listings, point/address lists, cross-reference listings, images of screens, data entry forms, and sample reports.

c. Manuals shall include instructions for program users and instructions for maintenance programmers.

D. Warranty: Submit in accordance with requirements of Division 0, covering the items included under this Section.

1.03 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of equipment, of types and sizes required, and whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards:

1. National Electric Code.

2. Applicable State and local requirements.

3. UL listing and labeling shall be adhered to.

C. Items covered by this Section are designated as undelivered specifically manufactured equipment for which associated progress payments will be made in accordance with this Specification.

D. Equipment that does not have a UL, FM, CSA, or other listed testing laboratory label shall be furnished with a notarized letter signed by the supplier stating that equipment furnished has been manufactured in accordance with National Electric Code and OSHA requirements.

E. CONSTRUCTION MANAGER shall provide permits and licenses, observe and abide by applicable laws, regulations, ordinances, and rules of State, territory or political subdivision thereof, wherein the Work is done. CONSTRUCTION MANAGER shall pay fees for permits, inspections, licenses, and certifications when such fees are required.

F. To ensure timely performance and conformance with Specifications, Project meetings shall be held at CONSTRUCTION MANAGER'S facility once every month during course of Project. Cost of such meetings shall be included.

G. Calibration Equipment and Testing Apparatus: Equipment supplier shall have available test and calibration equipment for factory panel tests, installation, start-up, service contract, and maintenance or troubleshooting purposes.
1. The equipment required for these tests is as follows:

a. One - Digital Multimeter with an accuracy of plus or minus 0.1 percent.

b. One - Signal calibrator for analog signals.

H. Component Requirements: For the purposes of uniformity and conformance to industry standards, signal transmission modes shall be electronic 4-20 mA DC only. No other signal characteristics are acceptable, except for remote temperature detector (RTD) and

thermocouple (TC) sensing circuits; 4-20 mA DC signals shall be such that devices may be wired in parallel for 1-5 volt DC as required. 1-5 volt DC mode shall be employed only within control panel enclosures.

I. Responsibility and Coordination: Drawings and Specifications are intended to include details of a complete equipment installation for purposes specified. CONSTRUCTION MANAGER shall be responsible for details which may be necessary to properly install, adjust, and place in operation complete installation. Any error on Drawings or in Specifications which prevents proper operation of supplied system shall be shown correct at time of Shop Drawing submittal for approval or brought to attention of CONSTRUCTION MANAGER with or prior to submittal.

J. CONSTRUCTION MANAGER shall be responsible for costs incurred to correct aforementioned errors brought to CONSTRUCTION MANAGER'S attention. CONSTRUCTION MANAGER shall assume full responsibility for additional costs which may result from unauthorized deviations from Specifications.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Manufactured material shall be adequately packed to prevent damage during shipping, handling, storage, and erection. Material shipped to Site shall be packed in a container properly marked for identification. Blocks and padding shall be used to prevent movement.

B. CONSTRUCTION MANAGER shall inspect the material prior to removing it from carrier. If damage is observed, CONSTRUCTION MANAGER shall immediately notify carrier so that a claim can be made. If no such notice is given, material shall be assumed to be in undamaged condition; any subsequent damage that occurs to the equipment shall be the responsibility of CONSTRUCTION MANAGER. Repair and replacement of damaged parts will be done at no expense to CONSTRUCTION MANAGER.

C. CONSTRUCTION MANAGER shall be responsible for any damage charges resulting from handling of materials.

PART 2 - PRODUCTS

2.01 EQUIPMENT SUPPLIERS

A. Subject to compliance with specified requirements, equipment suppliers shall be the following (no "or equals"):

1. DMC Denver, 1860 Blake Street, Denver, CO (303) 223-1801

2. Champion Technologies, 400 West Ironwood Drive, Salt Lake City, UT (801) 972-1868

B. References made in these Specifications to specific manufacturer's products are intended to serve as a guide to type, construction, and materials. Listing of a manufacturer does not imply acceptance by CONSTRUCTION MANAGER of a manufacturer's particular product, product line, or latest product revision if it does not meet Specifications.

C. Equipment Supplier: Equipment specified under Sections 13410 through 13450 and shown on Drawings shall be designed as a system, fabricated or purchased, shipped to Site, and started up by one of the qualified and approved equipment suppliers listed under this Section. Intent is for unit responsibility.

1. Equipment supplier shall not assign any of its rights or delegate any of its obligations under these Sections without prior written acceptance by CONSTRUCTION MANAGER.

2. Direct purchase of any items in these Sections by CONSTRUCTION MANAGER is not in compliance with this Specification and will not be permitted.

3. When a Service Contract is included, it shall be performed by factory-trained personnel employed by equipment supplier. Equipment supplier shall assign a qualified ENGINEER employed by the supplier as Project ENGINEER/Project Manager.

a. Project ENGINEER/Project Manager's name shall be forwarded to CONSTRUCTION MANAGER within 30 days after receipt of a purchase order by equipment supplier.

b. Project ENGINEER/Project Manager shall be focal point for design, fabrication, Contract communications, and shall be responsible for start-up and acceptance. Project ENGINEER/Project Manager shall be at factory test at Site for start-up and at the Site during entire acceptance procedure. Only qualified and approved equipment suppliers shall be accepted as meeting this Specification.

2.02 EQUIPMENT

A. Transmitted electronic signals to equipment of other vendors and between control panels shall be a separate isolated-floating output for each item of equipment and shall conform to ISA Standard S50.1.

B. Enclosures shall be NEMA 12, 4, 4X, or 7 as indicated on Drawings. Intrinsically safe systems, as approved by Factory Mutual, shall be furnished when called for.

C. No external power connections shall be allowed unless specifically called for in Specification. Where an external power source is called for, unit shall accept 120 VAC, plus or minus 10 percent power.

D. Current-to-current converters shall be used as power boosters to provide sufficient signal power as required. It is equipment supplier's responsibility to determine under what circumstances and locations power boosters are required, provide them, and integrate them into the instrumentation system to make system function properly.

E. Separate power supplies shall be totally enclosed with solderless terminals for connections. They shall be short circuit current limiting type that will automatically resume regulation after removal of short circuit. They shall operate from 120 volt AC, plus or minus 10 percent power. Regulated voltage shall be fixed. Units with internal trim potentiometers will be accepted.

1. Instruments shall be panel-mounted or enclosed for wall mounting as shown on Drawings.

F. Size and style of instruments are defined in Specifications.

G. Solid-state output switches, where used, shall be overvoltage transient protected and not be damaged by dI/dT or dv/dt for their design application under this Contract.

H. Instruments shall be equipped with permanently attached identification tag. Tag shall be included on field-mounted and panel-mounted devices. Tags shall include CONSTRUCTION MANAGER'S tag identification and manufacturer's tag identification if different from CONSTRUCTION MANAGER'S.

1. Tags shall be either stamped metal or laminated phenolic with black letters engraved on a white background. Field-mounted devices shall have tags fastened with screws. Devices mounted in panels will be tagged inside panel on subplates or on device itself where it can be easily read.

I. Finish on instruments and accessories shall provide protection against corrosion by elements in environment in which they are to be installed. Both the interior and exterior of enclosures shall be finished. Extra paint of each color used on material shall be provided by manufacturer for touch-up purposes.

J. Provide equipment identification nameplates complying with Section 16075, Electrical Identification. Nameplates shall contain CONSTRUCTION MANAGER'S item designation and, for indicators and transmitters, design range and units of device shown.

2.03 SOURCE QUALITY CONTROL

A. Control and monitoring system control panels and computer equipment, if any, shall be tested and witnessed by CONSTRUCTION MANAGER at the factory prior to shipment

to Site. CONSTRUCTION MANAGER to have option to witness all factory tests. CONSTRUCTION MANAGER shall be given 4 weeks notice before factory test date. Factory test shall include checking for conformity to Specifications, fabrication, and nomenclature. Control and monitoring system logic and terminals shall be checked line by line and function by function in total for conformity of Drawings.

B. Equipment supplier shall have test equipment available at the factory. A full set of annotated logic programs and wiring diagrams with the latest revisions shall be made available to CONSTRUCTION MANAGER at factory for checking purposes. Drawings shall include wire numbers and terminal numbers.

C. Control panels and programmable equipment shall not be shipped to Site until logic conforms to Contract requirements, physical changes required by testing are made, and tags conform to factory test corrections. Equipment delivered to Site without factory test or corrections will be returned to factory at CONSTRUCTION MANAGER'S expense.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Equipment provided under this Section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with detail drawings, specifications, engineering data, instructions, and recommendations of equipment manufacturer as approved by CONSTRUCTION MANAGER.

B. Install equipment as indicated, in accordance with manufacturer's written instruction, and in compliance with recognized industry practices to ensure that products fulfill requirements.

C. Elements that are supported by plumbing or piping, or that have only plumbing or piping connections shall be installed under those Sections.

D. Plumbing, piping, or pneumatic signal connections to elements requiring such connections shall be made under those Sections. Control panels shall be installed in accordance with Division 16 Sections, with piping connections to control panels installed under Division 15 Sections.

E. Drawings are not intended to show every detail of construction or location of conduit or equipment. Where proper operation or construction makes it necessary or advisable to change location of conduit, instrumentation equipment, air ducts, or other equipment, Equipment supplier shall so inform CONSTRUCTION MANAGER for his approval and permission.

3.02 FIELD QUALITY CONTROL

A. Calibrate equipment in accordance with manufacturer's instructions to ranges or set points indicated on Drawings.

B. Installation and Start-up: Equipment supplier shall have an established service facility from which qualified technical service personnel and parts may be dispatched upon call. Such a service facility shall be no more than 6 hours travel time from Site.

1. Equipment supplier shall provide an experienced, factory-trained, competent, and authorized service representative for a minimum of 3 times at Site, including once during installation and start-up and once during acceptance to inspect, check, and calibrate any part of system. Supplier's service representative shall revisit Site for 8 hours per day as often as necessary after installation until trouble is corrected and equipment has passed acceptance test and is operating satisfactorily to ENGINEER.

2. Third trip is after equipment has been accepted and shall be used to instruct CONSTRUCTION MANAGER'S personnel in aspects of operation and maintenance, such as fuse locations, use of controls, operator interface, instruction manuals, etc. Third trip shall be for duration of two, 8-hour days at CONSTRUCTION MANAGER'S facility.

C. Equipment supplier shall provide two, 8-hour days of training for CONSTRUCTION MANAGER'S personnel in aspects of operation and maintenance such as use of controls, fuse locations, instruction manuals, etc.

1. Training and instructions at the plant shall be given by the Project ENGINEER assigned to the Project by the equipment supplier or other personnel as approved by CONSTRUCTION MANAGER.

D. Digital Equipment Field Training: At conclusion of field acceptance tests, Equipment Supplier shall conduct a training course on site for CONSTRUCTION MANAGER'S personnel in use of system.

1. Course shall be 3 days duration and shall consist of hands-on use of system.

2. Written course materials shall be provided to each participant for use during instruction and to serve as a basic reference document after training.

3.03 TRAINING

A. Digital Equipment: Equipment supplier shall provide comprehensive instruction for the programmable controller, operator interface, computers, and software packages supplied. This instruction shall be performed by manufacturer of the products at the project site. Equipment supplier shall submit to CONSTRUCTION MANAGER an outline of the proposed training courses to meet the requirements set forth below. Equipment supplier shall also provide to CONSTRUCTION MANAGER a list of additional courses available from manufacturer. Upon

review, CONSTRUCTION MANAGER may request that a substitution be made of a course content that better fits the needs of CONSTRUCTION MANAGER. Such substitution shall only be requested for courses of equal length, cost, and availability. The content of these courses and proposed lengths shall be as follows:

1. Programmable Logic Controller Training (6 individuals):

    a. Allen Bradley Courses:
        1) Allen Bradley CompactLogix Maintenance and Troubleshooting 2 days
        2) Maintenance and Troubleshooting of Allen Bradley Step 7 4 days

2. SCADA Software (6 individuals - 2 trips):

    a. VTScada Training Courses:
        1) VTScada Maintenance 2 days

3. OIP Software Training (6 Individuals)

    a. Rockwell Factory Talk View ME

4. Field Instrumentation Training

    a. Endress Hauser Training:
        1) Endress Hauser Liquiline and Instrument Maintenance 1 day

B. Equipment Supplier shall bear transportation and subsistence costs for the specified training and shall arrange for training for CONSTRUCTION MANAGER with a minimum of 6-week notification of the training schedule prior to the actual course being provided. Scheduling of the courses and their contents shall be approved by CONSTRUCTION MANAGER and provided at a time and location agreeable to CONSTRUCTION MANAGER. The course shall be conducted at locations normally established for such courses by manufacturers of the software and computer products.

3.04 DEMONSTRATION

A. Upon completion of installation and calibration, demonstrate functioning of equipment in accordance with requirements. Where possible, correct malfunctioning units at Site, then retest to demonstrate compliance; otherwise, remove and replace with new or repaired units, and retest to demonstrate compliance.

B. Failure to complete the project in the time agreed to and in compliance with the contract terms will result in liquidated damages in the amount of $500 per day.

END OF SECTION

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SPECIFICATION REVISION INDEX

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A	11/28/2016	60% Submittal			JG	STD	
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SECTION 13421

FLOW MEASUREMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Magnetic flow meters.

1.02 SUBMITTALS

A. Shop Drawings: Submit in accordance with Division 1, Shop Drawings covering the items included under this Section.

B. Contract Closeout: Submit in accordance with Division 1.

C. Operation and Maintenance Manuals: Submit in accordance with Division 1.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:

1. Magnetic Flow Meter:

a. Rosemount
b. Endress Hauser.
c. Siemens.

2.02 MAGNETIC FLOW METER

A. Magnetic flow meters shall be either flanged or flangeless type as indicated on the Drawings. Meters 4 inches or smaller shall be wafer or flange style. Meters 6-inch or larger shall be of flange design.

B. Units shall be capable of standard flow and mass flow, field selectable.

C. Meter body shall be Schedule 10, 304 stainless steel with 150-pound ANSI flange or AWWA Class D flanges when ANSI is not an available option. Meters shall have a Teflon, Tefzel (Ethylene Tetrafluoroethylene) and platinum, Type 316 stainless steel, or Tantalum electrodes.

D. Electrodes shall be suitable for the process flow indicated on the Drawings.

E. Start-up and acceptance check for flow meters shall be performed by a qualified employee of flow meter manufacturer. Service personnel of sales representative or of equipment supplier of this Section will not be accepted.

F. Magnetic flow meter signal converter shall consist of solid-state, feedback-type microprocessor circuitry. Operational parameters shall be user configurable locally via an integral push-button arrangement or via a remote intelligent terminal. Appurtenances, including hand-held programmer and/or programming software, shall be provided for local configuration of operational parameters. Converter shall change a low-level flow signal from sensor electrodes into a proportional isolated 4-20 mA DC signal. The converter shall have an extremely high input impedance and not be affected by quadrature noise. The unit shall be capable of accommodating uni-directional or bi-directional flow. Sensing of meter failure shall activate a user-configurable zero or 130 percent output signal and a failure alarm contact closure.

G. Where indicated on Drawings, a high-frequency digital proportional output shall be provided for use with high-accuracy totalizers. To eliminate errors, the converter shall incorporate an integral zero return circuit to provide a constant zero output signal in response to an external dry contact closure. An automatic empty pipe detector and low-flow cutoff shall be provided as standard.

H. Meters shall be electronically isolated for grounding. Where insulated or nonconductive pipe is used, only orifice plate-type grounding rings will be acceptable. Grounding electrodes which penetrate the liner will not be acceptable.

I. Units shall be supplied with a local conduit-mounted flow indicator calibrated in engineering units. Indicator shall be tagged showing design range in units being measured and shall be capable of simultaneously displaying flow rate and totalization with an alphanumeric display.

J. Zero stability shall be achieved by pulsing the sensing head magnetic field coils with a regulated direct current, first in one direction and then in opposite direction.

K. Continuous zero stability shall be obtained by signal sampling during the quiescent coil states. There shall be no zero offset or zero adjustments required. The converter shall not require calibration over its expected life under normal use.

L. Flow meter shall operate within Specifications on 120 volt AC plus 10 percent and 60 hertz plus 5 percent. Power consumption shall not exceed 25 VA for meters 24 inches and smaller, and 50 VA for meters 30 inches or greater.

M. Input span shall be adjustable between 0-1 and 0-30 feet per second and range adjustment shall be digital. Converter shall include adjustable damping circuitry. Unit

shall not be affected by power line aberrations such as those produced by SCR-type motor controllers or other voltage transients.

N. System accuracy, including primary magnetic flow meter, shall be plus 0.5 percent of rate for maximum flow velocities from 1.33 to 33.33 feet per second, and plus 1 percent of rate for maximum flow velocities from 0.7 to 1.32 feet per second. Repeatability shall be plus 0.1 percent of span. Rangeability shall meet or exceed 30:1 turndown.

O. The signal converter portion of the magnetic flow meter shall include both a magnetic driver to power the magnetic coils and the signal converter electronics. The converter shall have the ability to be remotely mounted as specified. The converter shall be remotely mounted and housed in a NEMA 4X case with sun shields on the top and sides. When remotely mounted, the signal cable shall be provided with the proper length.

P. Magmeter manufacturer shall comply with ISO9000 Standards and the meter shall be FM approved. Signal converters shall be interchangeable without effect of meter accuracy or the need for recalibration for all meter sizes.

Q. See attachements 13421 for detailed specification sheets.

PART 3 - EXECUTION

3.01 GENERAL

A. Examination, Installation, Field Quality Control, Demonstration: In accordance with Section 13410: Basic Instrumentation, Monitoring and Control Requirements.

END OF SECTION

13421 ATTACHMENT A - FLOW MEASUREMENT DATA SHEET

PRODUCT	**Flow Meter - Magnetic Flow Tube**		SHEET 1 OF 3	
PROJECT	NERT WEIR DEWATERING TREATMENT		SPEC. NO. 13421 Attachments	ATTACHMENT NO. A
TAG NO.	**FE / FIT - 2010**	**FE / FIT - 3010**	**FE / FIT - 4010**	
Ref. Dwg. No.: 1	I-201	I-301	I-401	
PROCESS				
Location: 2	Sunrise Mountain Pump Station	Historic Lateral	Central Water Treatment Plant	
Service: 3	Influent Tank Feed Header	Influent Tank Feed Header	Plant Influent	
Vessel / Line No.: 4	CS-RW-X	CS-RW-X	CS-RW-X	
Fluid: 5	Surface Water with < X.X% AP	Surface Water with < X.X% AP	Surface Water with < X.X% AP	
Temp. Min/Max: 6	65 / 90 degrees F	65 / 90 degrees F	65 / 90 degrees F	
Flow Min/Max: 7	50-6,900 gpm	50-6,900 gpm	50-6,900 gpm	
PERFORMANCE				
Range: 8	50-9,000 gpm	50-9,000 gpm	50-9,000 gpm	
Accuracy: 9	±0.5% of flow rate over 1-39 fps range; ±0.005 fps for flows below 1 fps.	±0.5% of flow rate over 1-39 fps range; ±0.005 fps for flows below 1 fps.	±0.5% of flow rate over 1-39 fps range; ±0.005 fps for flows below 1 fps.	
Temperature: 10	0 to 140 degrees F.	0 to 140 degrees F.	0 to 140 degrees F.	
Repeatability: 11	±0.2% of range.	±0.2% of range.	±0.2% of range.	
Fluid Conductivity: 12	Minimum Limit: 5 µS/cm.	Minimum Limit: 5 µS/cm.	Minimum Limit: 5 µS/cm.	
Impedance: 13	Minimum Pre-amp Input: 1012 ohms.	Minimum Pre-amp Input: 1012 ohms.	Minimum Pre-amp Input: 1012 ohms.	
Drift: 14	Complete zero stability.	Complete zero stability.	Complete zero stability.	
FLOW TUBE				
Type: 15	Lined Metal Flow Tube.	Lined Metal Flow Tube.	Stainless Steel Flow Tubes	
Element: 16	Conical or Elliptical Shaped Electrode.	Conical or Elliptical Shaped Electrode.		
Electrode/Liner: 17	XXXX	XXXX	300 Series Stainless Steel	
Line Size: 18	16"	16"	16"	
Enclosure/Housing: 19	Die-cast, Low-copper Aluminum Alloy; Submersible in 30 feet water for 48 hours; Epoxy paint finish.	Die-cast, Low-copper Aluminum Alloy; Submersible in 30 feet water for 48 hours; Epoxy paint finish.	Die-cast, Low-copper Aluminum Alloy; Submersible in 30 feet water for 48 hours; Epoxy paint finish.	
Mounting: 19	Flange End Connections.	Flange End Connections.	Flange End Connections.	
ANSI Class: 20	Class 150	Class 152	Class 150	
Additional Features: 21	316 S.S. Grounding Rings/Straps.	316 S.S. Grounding Rings/Straps.	316 S.S. Grounding Rings/Straps.	
TRANSMITTER				
Type: 22	Pulsed DC Magnetic Flow Transmitter.	Pulsed DC Magnetic Flow Transmitter.	Pulsed DC Magnetic Flow Transmitter.	
Output: 23	4-20 mADC direct-acting, galvanically isolated; into 0-1000 ohms.	4-20 mADC direct-acting, galvanically isolated; into 0-1000 ohms.	4-20 mADC direct-acting, galvanically isolated; into 0-1000 ohms.	
Power Supply: 24	120 VAC ±10%, 60 Hz ±3 Hz.	120 VAC ±10%, 60 Hz ±3 Hz.	120 VAC ±10%, 60 Hz ±3 Hz.	
Indication / Display: 25	Local LCD; Display Flow in Engineering Units; Provide Totalizer (See Notes, Line 39).	Local LCD; Display Flow in Engineering Units; Provide Totalizer (See Notes, Line 39).	Local LCD; Display Flow in Engineering Units; Provide Totalizer (See Notes, Line 39).	
Enclosure/Housing: 26	Integral; Solid state construction.	Integral; Solid state construction.	Integral; Solid state construction.	
Mounting: 27	Integral, Field Mount	Integral, Field Mount	Integral, Field Mount	
Connections: 28	Electrical Conn.: 1/2 inch NPT.	Electrical Conn.: 1/2 inch NPT.	Electrical Conn.: 1/2 inch NPT.	
Commun. Cable: 29	Shielded Cable to flow tube.	Shielded Cable to flow tube.	Shielded Cable to flow tube.	
Area Classification: 30	Not Applicable	Not Applicable	Not Applicable	
Additional Features: 31	Automatic zeroing.	Automatic zeroing.	Automatic zeroing.	
NOTES				
Function: 32	System shall monitor liquid flows, display monitored flow value, and output a signal proportional to monitored flow.			
Installation: 33	Refer to Contract Drawing Installation Details and manufacturer's recommendations for installation.			
Calibration: 34	Provide ISO Factory Calibration Certificate. Provide one calibrator suitable to calibrate all flow tubes provided.			
Accuracy: 35	Accuracy shall be: - Unaffected by changes in fluid velocity, density, pressure, temp. or conductivity (above min. conductivity limits). - Verified by flow test curves. Submit flow test curves for furnished meters with a minimum of 10 equally spaced flow points, using water and a weight or volume tank. A "master meter" used as a reference standard is not acceptable. A test setup shall be submitted and approved prior to testing.			
Span Adjustment: 36	Unit shall have pre-calibrated continuous span adjustment over entire range. Provide direct reading thumbwheel switch or potentiometer for 1-39 ft/sec.			
Signal Conditioning: 37	Adjustable signal conditioning damping circuit with response times of 1-25 seconds minimum.			
Low Flow Cutoff: 38	Automatic low flow cutoff circuitry shall stop pulse output and local totalization when flow drops below 0.5% ±0.2% of calibrated upper range value.			
Totalizer: 39	Totalizer shall be: - 7-digit electromechanical or 8-digit electronic LCD unit, with reset and lithium battery backup. - Driven by high accuracy, field adjustable scaled pulse output (0.1-10 Hz or greater). - Integral with transmitter and visible through viewing window, or externally mounted adjacent to transmitter in a separate NEMA 4X enclosure or condulet with viewing window.			
Spool Piece: 40	Provide a replacement spool piece for each size flow tube where no bypass piping is provided.			
41				
MANUFACTURE	Provide products of one of the following, Or Equal:			
Manufacturer: 42	Rosemount	Endress Hauser	Siemens	

13421 ATTACHMENT A - FLOW MEASUREMENT DATA SHEET

PRODUCT	**Flow Meter - Magnetic Flow Tube**		SHEET 2 OF 3	
PROJECT	NERT WEIR DEWATERING TREATMENT		SPEC. NO. 13421 Attachments	ATTACHMENT NO. A
TAG NO.	**FE / FIT - 8020**	**FE / FIT - 8040**	**FE / FIT - 8045**	
Ref. Dwg. No.: 1	I-802	I-803	I-803	
PROCESS				
Location: 2	Central Water Treatment Plant	Central Water Treatment Plant	Central Water Treatment Plant	
Service: 3	Cyclone Waste to BW Waste Tank	Cyclone Waste to BW Waste Tank	BW Waste to Effluent Discharge	
Vessel / Line No.: 4	CS-CW-X	CS-CW-X	CS-BWW-X	
Fluid: 5	Surface Water with < X.X% AP	Surface Water with < X.X% AP	Surface Water with < X.X% AP	
Temp. Min/Max: 6	65 / 90 degrees F	65 / 90 degrees F	65 / 90 degrees F	
Flow Min/Max: 7	10-70 gpm	10-70 gpm	50-550 gpm	
PERFORMANCE				
Range: 8	5-200 gpm	5-200 gpm	5-900 gpm	
Accuracy: 9	±0.5% of flow rate over 1-39 fps range; ±0.005 fps for flows below 1 fps.	±0.5% of flow rate over 1-39 fps range; ±0.005 fps for flows below 1 fps.	±0.5% of flow rate over 1-39 fps range; ±0.005 fps for flows below 1 fps.	
Temperature: 10	0 to 140 degrees F.	0 to 140 degrees F.	0 to 140 degrees F.	
Repeatability: 11	±0.2% of range.	±0.2% of range.	±0.2% of range.	
Fluid Conductivity: 12	Minimum Limit: 5 µS/cm.	Minimum Limit: 5 µS/cm.	Minimum Limit: 5 µS/cm.	
Impedance: 13	Minimum Pre-amp Input: 1012 ohms.	Minimum Pre-amp Input: 1012 ohms.	Minimum Pre-amp Input: 1012 ohms.	
Drift: 14	Complete zero stability.	Complete zero stability.	Complete zero stability.	
FLOW TUBE				
Type: 15	Stainless Steel Flow Tubes	Stainless Steel Flow Tubes	Stainless Steel Flow Tubes	
Element: 16				
Electrode/Liner: 17	300 Series Stainless Steel	300 Series Stainless Steel	300 Series Stainless Steel	
Line Size: 18	2"	3"	6"	
Enclosure/Housing: 19	Die-cast, Low-copper Aluminum Alloy; Submersible in 30 feet water for 48 hours; Epoxy paint finish.	Die-cast, Low-copper Aluminum Alloy; Submersible in 30 feet water for 48 hours; Epoxy paint finish.	Die-cast, Low-copper Aluminum Alloy; Submersible in 30 feet water for 48 hours; Epoxy paint finish.	
Mounting: 19	Flange End Connections.	Flange End Connections.	Flange End Connections.	
ANSI Class: 20	Class 150	Class 150	Class 150	
Additional Features: 21	316 S.S. Grounding Rings/Straps.	316 S.S. Grounding Rings/Straps.	316 S.S. Grounding Rings/Straps.	
TRANSMITTER				
Type: 22	Pulsed DC Magnetic Flow Transmitter.	Pulsed DC Magnetic Flow Transmitter.	Pulsed DC Magnetic Flow Transmitter.	
Output: 23	4-20 mADC direct-acting, galvanically isolated; into 0-1000 ohms.	4-20 mADC direct-acting, galvanically isolated; into 0-1000 ohms.	4-20 mADC direct-acting, galvanically isolated; into 0-1000 ohms.	
Power Supply: 24	120 VAC ±10%, 60 Hz ±3 Hz.	120 VAC ±10%, 60 Hz ±3 Hz.	120 VAC ±10%, 60 Hz ±3 Hz.	
Indication / Display: 25	Local LCD; Display Flow in Engineering Units; Provide Totalizer (See Notes, Line 39).	Local LCD; Display Flow in Engineering Units; Provide Totalizer (See Notes, Line 39).	Local LCD; Display Flow in Engineering Units; Provide Totalizer (See Notes, Line 39).	
Enclosure/Housing: 26	Integral; Solid state construction.	Integral; Solid state construction.	Integral; Solid state construction.	
Mounting: 27	Integral, Field Mount	Integral, Field Mount	Integral, Field Mount	
Connections: 28	Electrical Conn.: 1/2 inch NPT.	Electrical Conn.: 1/2 inch NPT.	Electrical Conn.: 1/2 inch NPT.	
Commun. Cable: 29	Shielded Cable to flow tube.	Shielded Cable to flow tube.	Shielded Cable to flow tube.	
Area Classification: 30	Not Applicable	Not Applicable	Not Applicable	
Additional Features: 31	Automatic zeroing.	Automatic zeroing.	Automatic zeroing.	
NOTES				
Function: 32	System shall monitor liquid flows, display monitored flow value, and output a signal proportional to monitored flow.			
Installation: 33	Refer to Contract Drawing Installation Details and manufacturer's recommendations for installation.			
Calibration: 34	Provide ISO Factory Calibration Certificate. Provide one calibrator suitable to calibrate all flow tubes provided.			
Accuracy: 35	Accuracy shall be: - Unaffected by changes in fluid velocity, density, pressure, temp. or conductivity (above min. conductivity limits). - Verified by flow test curves. Submit flow test curves for furnished meters with a minimum of 10 equally spaced flow points, using water and a weight or volume tank. A "master meter" used as a reference standard is not acceptable. A test setup shall be submitted and approved prior to testing.			
Span Adjustment: 36	Unit shall have pre-calibrated continuous span adjustment over entire range. Provide direct reading thumbwheel switch or potentiometer for 1-39 ft/sec.			
Signal Conditioning: 37	Adjustable signal conditioning damping circuit with response times of 1-25 seconds minimum.			
Low Flow Cutoff: 38	Automatic low flow cutoff circuitry shall stop pulse output and local totalization when flow drops below 0.5% ±0.2% of calibrated upper range value.			
Totalizer: 39	Totalizer shall be: - 7-digit electromechanical or 8-digit electronic LCD unit, with reset and lithium battery backup. - Driven by high accuracy, field adjustable scaled pulse output (0.1-10 Hz or greater). - Integral with transmitter and visible through viewing window, or externally mounted adjacent to transmitter in a separate NEMA 4X enclosure or condulet with viewing window.			
Spool Piece: 40	Provide a replacement spool piece for each size flow tube where no bypass piping is provided.			
41				
MANUFACTURE	Provide products of one of the following, Or Equal:			
Manufacturer: 42	Rosemount	Endress Hauser	Siemens	

13421 ATTACHMENT A - FLOW MEASUREMENT DATA SHEET

PRODUCT	**Flow Meter - Magnetic Flow Tube**		SHEET 3 OF 3	
PROJECT	NERT WEIR DEWATERING TREATMENT		SPEC. NO. 13421 Attachments	ATTACHMENT NO. A
TAG NO.	**FE / FIT - 8050**	**FE / FIT - 8060**	**FE / FIT - 8065**	
Ref. Dwg. No.: 1	I-805	I-806	I-806	
PROCESS				
Location: 2	Central Water Treatment Plant	Central Water Treatment Plant	Central Water Treatment Plant	
Service: 3	Treated Water to MM Filter Rinse/BW	Treated Water to Las Vegas Wash	Filter Rinse to Ion Exchange Feed	
Vessel / Line No.: 4	CS-TW-X	CS-TW-X	CS-RW-X	
Fluid: 5	Surface Water with < X.X% AP	Surface Water with < X.X% AP	Surface Water with < X.X% AP	
Temp. Min/Max: 6	65 / 90 degrees F	65 / 90 degrees F	65 / 90 degrees F	
Flow Min/Max: 7	500-5,500 gpm	50-550 gpm	50-550 gpm	
PERFORMANCE				
Range: 8	15-6,000 gpm	5-900 gpm	5-900 gpm	
Accuracy: 9	±0.5% of flow rate over 1-39 fps range; ±0.005 fps for flows below 1 fps.	±0.5% of flow rate over 1-39 fps range; ±0.005 fps for flows below 1 fps.	±0.5% of flow rate over 1-39 fps range; ±0.005 fps for flows below 1 fps.	
Temperature: 10	0 to 140 degrees F.	0 to 140 degrees F.	0 to 140 degrees F.	
Repeatability: 11	±0.2% of range.	±0.2% of range.	±0.2% of range.	
Fluid Conductivity: 12	Minimum Limit: 5 µS/cm.	Minimum Limit: 5 µS/cm.	Minimum Limit: 5 µS/cm.	
Impedance: 13	Minimum Pre-amp Input: 1012 ohms.	Minimum Pre-amp Input: 1012 ohms.	Minimum Pre-amp Input: 1012 ohms.	
Drift: 14	Complete zero stability.	Complete zero stability.	Complete zero stability.	
FLOW TUBE				
Type: 15	Stainless Steel Flow Tubes	Stainless Steel Flow Tubes	Stainless Steel Flow Tubes	
Element: 16				
Electrode/Liner: 17	300 Series Stainless Steel	300 Series Stainless Steel	300 Series Stainless Steel	
Line Size: 18	8"	16"	4"	
Enclosure/Housing: 19	Die-cast, Low-copper Aluminum Alloy; Submersible in 30 feet water for 48 hours; Epoxy paint finish.	Die-cast, Low-copper Aluminum Alloy; Submersible in 30 feet water for 48 hours; Epoxy paint finish.	Die-cast, Low-copper Aluminum Alloy; Submersible in 30 feet water for 48 hours; Epoxy paint finish.	
Mounting: 19	Flange End Connections.	Flange End Connections.	Flange End Connections.	
ANSI Class: 20	Class 150	Class 150	Class 150	
Additional Features: 21	316 S.S. Grounding Rings/Straps.	316 S.S. Grounding Rings/Straps.	316 S.S. Grounding Rings/Straps.	
TRANSMITTER				
Type: 22	Pulsed DC Magnetic Flow Transmitter.	Pulsed DC Magnetic Flow Transmitter.	Pulsed DC Magnetic Flow Transmitter.	
Output: 23	4-20 mADC direct-acting, galvanically isolated; into 0-1000 ohms.	4-20 mADC direct-acting, galvanically isolated; into 0-1000 ohms.	4-20 mADC direct-acting, galvanically isolated; into 0-1000 ohms.	
Power Supply: 24	120 VAC ±10%, 60 Hz ±3 Hz.	120 VAC ±10%, 60 Hz ±3 Hz.	120 VAC ±10%, 60 Hz ±3 Hz.	
Indication / Display: 25	Local LCD; Display Flow in Engineering Units; Provide Totalizer (See Notes, Line 39).	Local LCD; Display Flow in Engineering Units; Provide Totalizer (See Notes, Line 39).	Local LCD; Display Flow in Engineering Units; Provide Totalizer (See Notes, Line 39).	
Enclosure/Housing: 26	Integral; Solid state construction.	Integral; Solid state construction.	Integral; Solid state construction.	
Mounting: 27	Integral, Field Mount	Integral, Field Mount	Integral, Field Mount	
Connections: 28	Electrical Conn.: 1/2 inch NPT.	Electrical Conn.: 1/2 inch NPT.	Electrical Conn.: 1/2 inch NPT.	
Commun. Cable: 29	Shielded Cable to flow tube.	Shielded Cable to flow tube.	Shielded Cable to flow tube.	
Area Classification: 30	Not Applicable	Not Applicable	Not Applicable	
Additional Features: 31	Automatic zeroing.	Automatic zeroing.	Automatic zeroing.	
NOTES				
Function: 32	System shall monitor liquid flows, display monitored flow value, and output a signal proportional to monitored flow.			
Installation: 33	Refer to Contract Drawing Installation Details and manufacturer's recommendations for installation.			
Calibration: 34	Provide ISO Factory Calibration Certificate. Provide one calibrator suitable to calibrate all flow tubes provided.			
Accuracy: 35	Accuracy shall be: - Unaffected by changes in fluid velocity, density, pressure, temp. or conductivity (above min. conductivity limits). - Verified by flow test curves. Submit flow test curves for furnished meters with a minimum of 10 equally spaced flow points, using water and a weight or volume tank. A "master meter" used as a reference standard is not acceptable. A test setup shall be submitted and approved prior to testing.			
Span Adjustment: 36	Unit shall have pre-calibrated continuous span adjustment over entire range. Provide direct reading thumbwheel switch or potentiometer for 1-39 ft/sec.			
Signal Conditioning: 37	Adjustable signal conditioning damping circuit with response times of 1-25 seconds minimum.			
Low Flow Cutoff: 38	Automatic low flow cutoff circuitry shall stop pulse output and local totalization when flow drops below 0.5% ±0.2% of calibrated upper range value.			
Totalizer: 39	Totalizer shall be: - 7-digit electromechanical or 8-digit electronic LCD unit, with reset and lithium battery backup. - Driven by high accuracy, field adjustable scaled pulse output (0.1-10 Hz or greater). - Integral with transmitter and visible through viewing window, or externally mounted adjacent to transmitter in a separate NEMA 4X enclosure or condulet with viewing window.			
Spool Piece: 40	Provide a replacement spool piece for each size flow tube where no bypass piping is provided.			
41				
MANUFACTURE	Provide products of one of the following, Or Equal:			
Manufacturer: 42	Rosemount	Endress Hauser	Siemens	

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SPECIFICATION REVISION INDEX

Revision No.	Revision Date	Issued for	Signatures				
			Prepared By	Reviewed By	Project Engineer	Project Manager	Client
A	1/27/2017	60% Submittal			JG	STD	
B	1/27/2017	DRAFT 90% Submittal			JG	STD	
C	2/15/2017	75% Submittal			JG	STD	

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SECTION 13423

LEVEL AND PRESSURE MEASUREMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes the following:

1. Sonic level transmitter (utilize for level).

2. Pressure Transmitter.

1.02 SUBMITTALS

A. Shop Drawings: Submit in accordance with Division 1, Shop Drawings covering the items included under this Section.

B. Contact Closeout: Submit in accordance with Division 1.

C. Fabricated and pre-engineered panels are subject to this specification.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:

1. Sonic Level Transmitter:

a. Rosemount.

b. Endress Hauser.

c. Siemens - Sitrans.

2. Pressure Transmitter

a. Rosemount

b. Endress Hauser

c. Siemens - Sitrans

2.02 SONIC LEVEL TRANSMITTER

A. Sonic level device shall be microprocessor-based and include sensing head, control cabinet, and cable between head and control cabinet.

B. Length of cable shall be sufficient for application shown.

C. Sensor shall automatically compensate for ambient temperature changes.

D. CONSTRUCTION MANAGER, equipment supplier, and manufacturer shall examine Drawings for each installation to determine equipment supplied will work in each application.

E. Drawings shall contain a typical installation detail and show location of sensors.

F. Equipment supplier must ensure beam angle of sensor shall not have interference from walls, pipes, or other objects at each location. Shop Drawings shall be specific about model numbers at each location, and detail sketches showing mounting height, zero dimensions, span dimensions, and beam angle data for each location.

G. Any device that will not function reliably to specifications in its application shall be replaced at CONSTRUCTION MANAGER'S expense.

H. Sensor head shall be epoxy-coated metal, encapsulated or mylar for corrosion resistance. Sensor head and reflector shall contain a thermostatically controlled heater for outdoor application for manufacturers that require sensor head heater for operation down to -20 degrees F.

I. Sonic frequency shall be less than 45 kHz. Frequencies above this range will not be accepted.

J. Control cabinet shall be supplied rated NEMA 4 or as shown on Drawings. Control cabinet shall contain a receiver processor, a full-hinged front door, a control cabinet thermostat controlled heater for -20 degrees F operation, and local digital indicator configured in engineering units.

K. Connections to controller and sonic sensor shall be with well-marked terminal blocks.

L. Field adjustments shall be made through membrane keypads. Units requiring the use of an oscilloscope will not be accepted.

M. Operational Data:

1. Temperature: Sensor to operate within specifications over -20 degrees F to 150 degrees F. Controller shall operate from 32 degrees F to 120 degrees F without heater, and -20 degrees F with a heater. Provide sun shade for sensor and transmitter.

2. Pulse Rate: 1.5 pps minimum sensing rate.

3. Operating Frequency: Less than 45 kHz.

4. Reflection Blocking: Adjustable receiver blanking to operate only on first pulse received.

5. Cable Length: Sensor and controller may be separated up to 500 feet.

6. AGC: Automatic gain control to maximize signal to noise ratio.

7. System Accuracy: Plus or minus 1.0 percent of full scale over the complete temperature range.

8. Power Supply: 120 volt AC plus or minus 10 percent at 60 hertz with power consumption of 100 watts maximum exclusive of controller heaters.

9. Output: 4-20 mA output linear with level into 0-700 ohms. Output shall be isolated, floating to prevent system ground loops when used with other control loops that have an established common at a remote location. Output time constant shall be adjustable through keypad from 1 to 10 seconds.

N. See Attachments 13423 for additional details.

2.03 PRESSURE TRANSMITTER

A. Pressure to current signal converter shall be 2-wire, solid-state electronic, temperature-compensated, strain gauge or capacitive type. Process pressure shall be applied to sealing diaphragm in measuring section. This pressure shall be transmitted to a measuring element connected to the electronics of the transmitter. Converter shall include a repairable circuit board mounted in a cast aluminum explosion-proof housing. Transmitter shall output an isolated 4-20 mA signal proportional to pressure measurement. Adjustable electronic damping shall be provided from 0 to 16 seconds in electronically adjustable increments of 0.1 second.

B. Positive overage protection shall be provided to 2,000 psig. Diaphragms and wetted parts shall be 316 stainless steel or ceramic, except where other special alloys are required to prevent corrosion.

C. Accuracy shall be within plus or minus 0.1 percent of calibrated span for spans from 1:1 to 15:1 of URL. Stability shall be plus or minus 0.1 percent of URL for 6 months. Zero suppression and elevation shall be at least 500 percent of range.

D. In applications where pressure transients may occur (i.e., level for elevated and ground storage tanks, pumping pressure, etc.), CONTRACTOR shall include snubbers in pressure tap line and an electronic signal time constant which will reduce pressure transients to plus or minus 1 percent of calibrated span. Time constant is to be achieved by placing it in panel providing power to pressure transmitter.

E. Units shall be supplied with an integral digital indicator calibrated 0 to 100 percent. Provide hand-held configurator. Provide sun shade for sensor and transmitter.

F. See Attachments 13423 for additional details.

PART 3 - EXECUTION

3.01 GENERAL

A. Examination, Installation, Field Quality Control, Demonstration: In accordance with Section 13410: Basic Instrumentation, Monitoring and Control Requirements.

END OF SECTION

13423 ATTACHMENT A - LEVEL MEASUREMENT DATA SHEET

PRODUCT	**Level Transmitter - Ultrasonic Type**		SHEET 1 OF 4	
PROJECT	NERT WEIR DEWATERING TREATMENT		SPEC. NO. 13423 Attachments	ATTACHMENT NO. A
TAG NO.	**LE / LIT - 2020**	**LE / LIT - 2021**	**LE / LIT - 3020**	
Ref. Dwg. No.: 1	I-202	I-202	I-302	
PROCESS				
Location: 2	Sunrise Mountain Pump Station	Historic Lateral Pump Station	Historic Lateral Pump Station	
Service: 3	Primary - Influent Tank TK-1B	Backup - Influent Tank TK-1C	Primary - Influent Tank TK-2B	
Vessel / Line No.: 4	Influent Tank TK-1B	Influent Tank TK-1C	Influent Tank TK-2B	
Fluid: 5	Surface Water with < 10% AP	Surface Water with < 10% AP	Surface Water with < 10% AP	
Temp. Min/Max: 6	65 / 90 degrees F	65 / 90 degrees F	65 / 90 degrees F	
Level Min/Max: 7	0 / 16 ft	0 / 16 ft	0 / 16 ft	
PERFORMANCE				
Range: 8	0-20 ft	0-20 ft	0-20 ft	
Accuracy: 9	±0.25% of Max. Range with Temperature Compensation.	±0.25% of Max. Range with Temperature Compensation.	±0.25% of Max. Range with Temperature Compensation.	
Temperature: 10	Electronics: -40 to 170 degrees F Transducer: -40 to 170 degrees F.	Electronics: -40 to 170 degrees F Transducer: -40 to 170 degrees F.	Electronics: -40 to 170 degrees F Transducer: -40 to 170 degrees F.	
Resolution: 11	±0.1% of Range or 2mm, greater of 2.	±0.1% of Range or 2mm, greater of 2.	±0.1% of Range or 2mm, greater of 2.	
Damping: 12	Adjustable.	Adjustable.	Adjustable.	
SENSOR				
Type: 13	Ultrasonic, Non-Contacting Transducer.	Ultrasonic, Non-Contacting Transducer.	Ultrasonic, Non-Contacting Transducer.	
Element: 14	Piezoelectric Barium Titanite Crystal.	Piezoelectric Barium Titanite Crystal.	Piezoelectric Barium Titanite Crystal.	
Blanking: 15	Adjustable Blanking Distance.	Adjustable Blanking Distance.	Adjustable Blanking Distance.	
Beam Angle: 16	(See Notes, Line 36).	(See Notes, Line 36).	(See Notes, Line 36).	
Enclosure/Housing: 17	Hermetically Sealed in Kynar.	Hermetically Sealed in Kynar.	Hermetically Sealed in Kynar.	
Mounting: 18	4" Flange Mount; Provide 316 S.S. Hardware/Brackets.	4" Flange Mount; Provide 316 S.S. Hardware/Brackets.	4" Flange Mount; Provide 316 S.S. Hardware/Brackets.	
Commun. Cable: 19	Communications Cable to transmitter, Length as required.	Communications Cable to transmitter, Length as required.	Communications Cable to transmitter, Length as required.	
Area Classification: 20	Not Applicable	Not Applicable	Not Applicable	
Additional Features: 21	Built-In Temperature Compensation Sensor.	Built-In Temperature Compensation Sensor.	Built-In Temperature Compensation Sensor.	
TRANSMITTER				
Type: 22	Microprocessor Based Control Circuitry Transmitter.	Microprocessor Based Control Circuitry Transmitter.	Microprocessor Based Control Circuitry Transmitter.	
Output: 23	4-20 mADC isolated, into 0-750 ohms.	4-20 mADC isolated, into 0-750 ohms.	4-20 mADC isolated, into 0-750 ohms.	
Power Supply: 24	24 VDC Loop Powered	24 VDC Loop Powered	24 VDC Loop Powered	
Relays: 25	Not Applicable	Not Applicable	Not Applicable	
Rating: 26	Not Applicable	Not Applicable	Not Applicable	
Indication / Display: 27	Multifield Back-lit LCD; Engineering Units; Loss of Echo Indication.	Multifield Back-lit LCD; Engineering Units; Loss of Echo Indication.	Multifield Back-lit LCD; Engineering Units; Loss of Echo Indication.	
Software: 28	As Required by Manufacturer.	As Required by Manufacturer.	As Required by Manufacturer.	
Enclosure/Housing: 29	Integral; Aluminum Enclosure.	Integral; Aluminum Enclosure.	Integral; Aluminum Enclosure.	
Mounting: 30	Integral; 316 S.S. Hardware.	Integral; 316 S.S. Hardware.	Integral; 316 S.S. Hardware.	
Area Classification: 31	Not Applicable	Not Applicable	Not Applicable	
Additional Features: 32	Electronic Filter to smooth signal variations.	Electronic Filter to smooth signal variations.	Electronic Filter to smooth signal variations.	
NOTES				
Function: 33	Ultrasonic Level Transmitter shall be a continuous liquid level measuring system which produces an output signal linear with level.			
Installation: 34	Refer to Contract Drawing Installation Details and manufacturer's recommendations for installation.			
Calibration: 35	Provide ISO Factory Calibration Certificate.			
Keypad: 36	Provide keypad for system programming and configuration. Programming and configuration values shall be stored in EEPROM memory that does not require battery back-up.			
37				
38				
39				
MANUFACTURE	Provide products of one of the following, Or Equal:			
Manufacturer: 40	Endress Hauser	Rosemount		

13423 ATTACHMENT B - LEVEL MEASUREMENT DATA SHEET

PRODUCT		Level Transmitter - Ultrasonic Type		SHEET 2 OF 4
PROJECT		NERT WEIR DEWATERING TREATMENT		SPEC. NO. 13423 Attachments / ATTACHMENT NO. B
TAG NO.		**LE / LIT - 3021**	**LE / LIT - 8010**	**LE / LIT - 8011**
Ref. Dwg. No.:	1	I-302	I-801	I-801
PROCESS				
Location:	2	Historic Lateral Pump Station	Central Water Treatment Plant	Central Water Treatment Plant
Service:	3	Backup - Influent Tank TK-2C	Primary - Treated Water Tank TK-4A	Primary - Filter Rinse Transfer Tank TK-
Vessel / Line No.:	4	Influent Tank TK-2C	Treated Water Tank TK-4A	Filter Rinse Transfer Tank TK-6
Fluid:	5	Surface Water with < 10% AP	Surface Water with < 10% AP	Surface Water with < 10% AP
Temp. Min/Max:	6	65 / 90 degrees F	65 / 90 degrees F	65 / 90 degrees F
Level Min/Max:	7	0 / 16 ft	0 / 16 ft	0 / 16 ft
PERFORMANCE				
Range:	8	0-20 ft	0-20 ft	0-20 ft
Accuracy:	9	±0.25% of Max. Range with Temperature Compensation.	±0.25% of Max. Range with Temperature Compensation.	±0.25% of Max. Range with Temperature Compensation.
Temperature:	10	Electronics: -40 to 170 degrees F Transducer: -40 to 170 degrees F.	Electronics: -40 to 170 degrees F Transducer: -40 to 170 degrees F.	Electronics: -40 to 170 degrees F Transducer: -40 to 170 degrees F.
Resolution:	11	±0.1% of Range or 2mm, greater of 2.	±0.1% of Range or 2mm, greater of 2.	±0.1% of Range or 2mm, greater of 2.
Damping:	12	Adjustable.	Adjustable.	Adjustable.
SENSOR				
Type:	13	Ultrasonic, Non-Contacting Transducer.	Ultrasonic, Non-Contacting Transducer.	Ultrasonic, Non-Contacting Transducer.
Element:	14	Piezoelectric Barium Titanite Crystal.	Piezoelectric Barium Titanite Crystal.	Piezoelectric Barium Titanite Crystal.
Blanking:	15	Adjustable Blanking Distance.	Adjustable Blanking Distance.	Adjustable Blanking Distance.
Beam Angle:	16	(See Notes, Line 36).	(See Notes, Line 36).	(See Notes, Line 36).
Enclosure/Housing:	17	Hermetically Sealed in Kynar.	Hermetically Sealed in Kynar.	Hermetically Sealed in Kynar.
Mounting:	18	4" Flange Mount; Provide 316 S.S. Hardware/Brackets.	4" Flange Mount; Provide 316 S.S. Hardware/Brackets.	4" Flange Mount; Provide 316 S.S. Hardware/Brackets.
Commun. Cable:	19	Communications Cable to transmitter, Length as required.	Communications Cable to transmitter, Length as required.	Communications Cable to transmitter, Length as required.
Area Classification:	20	Not Applicable	Not Applicable	Not Applicable
Additional Features:	21	Built-In Temperature Compensation Sensor.	Built-In Temperature Compensation Sensor.	Built-In Temperature Compensation Sensor.
TRANSMITTER				
Type:	22	Microprocessor Based Control Circuitry Transmitter.	Microprocessor Based Control Circuitry Transmitter.	Microprocessor Based Control Circuitry Transmitter.
Output:	23	4-20 mADC isolated, into 0-750 ohms.	4-20 mADC isolated, into 0-750 ohms.	4-20 mADC isolated, into 0-750 ohms.
Power Supply:	24	24 VDC Loop Powered	24 VDC Loop Powered	24 VDC Loop Powered
Relays:	25	Not Applicable	Not Applicable	Not Applicable
Rating:	26	Not Applicable	Not Applicable	Not Applicable
Indication / Display:	27	Multifield Back-lit LCD; Engineering Units; Loss of Echo Indication.	Multifield Back-lit LCD; Engineering Units; Loss of Echo Indication.	Multifield Back-lit LCD; Engineering Units; Loss of Echo Indication.
Software:	28	As Required by Manufacturer.	As Required by Manufacturer.	As Required by Manufacturer.
Enclosure/Housing:	29	Integral; Aluminum Enclosure.	Integral; Aluminum Enclosure.	Integral; Aluminum Enclosure.
Mounting:	30	Integral; 316 S.S. Hardware.	Integral; 316 S.S. Hardware.	Integral; 316 S.S. Hardware.
Area Classification:	31	Not Applicable	Not Applicable	Not Applicable
Additional Features:	32	Electronic Filter to smooth signal variations.	Electronic Filter to smooth signal variations.	Electronic Filter to smooth signal variations.
NOTES				
Function:	33	Ultrasonic Level Transmitter shall be a continuous liquid level measuring system which produces an output signal linear with level.		
Installation:	34	Refer to Contract Drawing Installation Details and manufacturer's recommendations for installation.		
Calibration:	35	Provide ISO Factory Calibration Certificate.		
Keypad:	36	Provide keypad for system programming and configuration. Programming and configuration values shall be stored in EEPROM memory that does not require battery back-up.		
	37			
	38			
	39			
MANUFACTURE		Provide products of one of the following, Or Equal:		
Manufacturer:	40	Endress Hauser	Rosemount	

13423 ATTACHMENT C - LEVEL MEASUREMENT DATA SHEET

PRODUCT		**Level Transmitter - Ultrasonic Type**		SHEET 3 OF 4
PROJECT		NERT WEIR DEWATERING TREATMENT		SPEC. NO. 13423 Attachments / ATTACHMENT NO. C
TAG NO.		**LE / LIT - 8012**	**LE / LIT - 8013**	**LE / LIT - 8020**
Ref. Dwg. No.:	1	I-801	I-801	I-802
PROCESS				
Location:	2	Central Water Treatment Plant	Central Water Treatment Plant	Central Water Treatment Plant
Service:	3	Backup - Filter Rinse Transfer Tank TK-	Backup - Treated Water Tank TK-4C	Primary - Cyclone Waste Tank TK-5
Vessel / Line No.:	4	Filter Rinse Transfer Tank TK-6	Treated Water Tank TK-4C	Cyclone Waste Tank TK-5
Fluid:	5	Surface Water with < 10% AP	Surface Water with < 10% AP	Surface Water with < 10% AP
Temp. Min/Max:	6	65 / 90 degrees F	65 / 90 degrees F	65 / 90 degrees F
Level Min/Max:	7	0 / 16 ft	0 / 16 ft	0 / 16 ft
PERFORMANCE				
Range:	8	0-20 ft	0-20 ft	0-20 ft
Accuracy:	9	±0.25% of Max. Range with Temperature Compensation.	±0.25% of Max. Range with Temperature Compensation.	±0.25% of Max. Range with Temperature Compensation.
Temperature:	10	Electronics: -40 to 170 degrees F Transducer: -40 to 170 degrees F.	Electronics: -40 to 170 degrees F Transducer: -40 to 170 degrees F.	Electronics: -40 to 170 degrees F Transducer: -40 to 170 degrees F.
Resolution:	11	±0.1% of Range or 2mm, greater of 2.	±0.1% of Range or 2mm, greater of 2.	±0.1% of Range or 2mm, greater of 2.
Damping:	12	Adjustable.	Adjustable.	Adjustable.
SENSOR				
Type:	13	Ultrasonic, Non-Contacting Transducer.	Ultrasonic, Non-Contacting Transducer.	Ultrasonic, Non-Contacting Transducer.
Element:	14	Piezoelectric Barium Titanite Crystal.	Piezoelectric Barium Titanite Crystal.	Piezoelectric Barium Titanite Crystal.
Blanking:	15	Adjustable Blanking Distance.	Adjustable Blanking Distance.	Adjustable Blanking Distance.
Beam Angle:	16	(See Notes, Line 36).	(See Notes, Line 36).	(See Notes, Line 36).
Enclosure/Housing:	17	Hermetically Sealed in Kynar.	Hermetically Sealed in Kynar.	Hermetically Sealed in Kynar.
Mounting:	18	4" Flange Mount; Provide 316 S.S. Hardware/Brackets.	4" Flange Mount; Provide 316 S.S. Hardware/Brackets.	4" Flange Mount; Provide 316 S.S. Hardware/Brackets.
Commun. Cable:	19	Communications Cable to transmitter, Length as required.	Communications Cable to transmitter, Length as required.	Communications Cable to transmitter, Length as required.
Area Classification:	20	Not Applicable	Not Applicable	Not Applicable
Additional Features:	21	Built-In Temperature Compensation Sensor.	Built-In Temperature Compensation Sensor.	Built-In Temperature Compensation Sensor.
TRANSMITTER				
Type:	22	Microprocessor Based Control Circuitry Transmitter.	Microprocessor Based Control Circuitry Transmitter.	Microprocessor Based Control Circuitry Transmitter.
Output:	23	4-20 mADC isolated, into 0-750 ohms.	4-20 mADC isolated, into 0-750 ohms.	4-20 mADC isolated, into 0-750 ohms.
Power Supply:	24	24 VDC Loop Powered	24 VDC Loop Powered	24 VDC Loop Powered
Relays:	25	Not Applicable	Not Applicable	Not Applicable
Rating:	26	Not Applicable	Not Applicable	Not Applicable
Indication / Display:	27	Multifield Back-lit LCD; Engineering Units; Loss of Echo Indication.	Multifield Back-lit LCD; Engineering Units; Loss of Echo Indication.	Multifield Back-lit LCD; Engineering Units; Loss of Echo Indication.
Software:	28	As Required by Manufacturer.	As Required by Manufacturer.	As Required by Manufacturer.
Enclosure/Housing:	29	Integral; Aluminum Enclosure.	Integral; Aluminum Enclosure.	Integral; Aluminum Enclosure.
Mounting:	30	Integral; 316 S.S. Hardware.	Integral; 316 S.S. Hardware.	Integral; 316 S.S. Hardware.
Area Classification:	31	Not Applicable	Not Applicable	Not Applicable
Additional Features:	32	Electronic Filter to smooth signal variations.	Electronic Filter to smooth signal variations.	Electronic Filter to smooth signal variations.
NOTES				
Function:	33	Ultrasonic Level Transmitter shall be a continuous liquid level measuring system which produces an output signal linear with level.		
Installation:	34	Refer to Contract Drawing Installation Details and manufacturer's recommendations for installation.		
Calibration:	35	Provide ISO Factory Calibration Certificate.		
Keypad:	36	Provide keypad for system programming and configuration. Programming and configuration values shall be stored in EEPROM memory that does not require battery back-up.		
	37			
	38			
	39			
MANUFACTURE		Provide products of one of the following, Or Equal:		
Manufacturer:	40	Endress Hauser	Rosemount	

13423 ATTACHMENT A - LEVEL MEASUREMENT DATA SHEET

PRODUCT		Level Transmitter - Ultrasonic Type		SHEET 4 OF 4
PROJECT		NERT WEIR DEWATERING TREATMENT	SPEC. NO. 13423 Attachments	ATTACHMENT NO. A
TAG NO.		**LE / LIT - 8021**	**Notes To Specifier:**	
Ref. Dwg. No.:	1	I-802	<- Specify Drawing Number where instrument is shown.	
PROCESS				
Location:	2	Central Water Treatment Plant	<- Specify Location of Instrument	
Service:	3	Backup - Cyclone Waste Tank TK-5	<- Specify Equipment that Instrument Services	
Vessel / Line No.:	4	Cyclone Waste Tank TK-5	<- Specify Vessel/Line No. if applicable	
Fluid:	5	Surface Water with < 10% AP	<- Specify Process Fluid.	
Temp. Min/Max:	6	65 / 90 degrees F	<- Specify Process Fluid Temperature Range	
Level Min/Max:	7	0 / 16 ft	<- Specify Actual Process Fluid Level Range	
PERFORMANCE				
Range:	8	0-20 ft	<- Specify Range	
Accuracy:	9	±0.25% of Max. Range with Temperature Compensation.		
Temperature:	10	Electronics: -40 to 170 degrees F Transducer: -40 to 170 degrees F.		
Resolution:	11	±0.1% of Range or 2mm, greater of 2.		
Damping:	12	Adjustable.		
SENSOR				
Type:	13	Ultrasonic, Non-Contacting Transducer.		
Element:	14	Piezoelectric Barium Titanite Crystal.		
Blanking:	15	Adjustable Blanking Distance.		
Beam Angle:	16	(See Notes, Line 36).	<- Replace [--NTS--] with: "12 degree beam angle" for range less than 33 feet, OR "5 degree l	
Enclosure/Housing:	17	Hermetically Sealed in Kynar.		
Mounting:	18	4" Flange Mount; Provide 316 S.S. Hardware/Brackets.	<- Replace [--NTS--] with: "Flange Mount", "Threaded Pipe Mount", OR other mounting requir	
Commun. Cable:	19	Communications Cable to transmitter, Length as required.	<- OPTIONAL: Specify approximate cable length if known. Format as follows: "approx. XXX fe	
Area Classification:	20	Not Applicable	<- Identify area classification OR specify "Not Applicable". Refer to Area Classification Chart.	
Additional Features:	21	Built-In Temperature Compensation Sensor.		
TRANSMITTER				
Type:	22	Microprocessor Based Control Circuitry Transmitter.		
Output:	23	4-20 mADC isolated, into 0-750 ohms.		
Power Supply:	24	24 VDC Loop Powered		
Relays:	25	Not Applicable		
Rating:	26	Not Applicable		
Indication / Display:	27	Multifield Back-lit LCD; Engineering Units; Loss of Echo Indication.		
Software:	28	As Required by Manufacturer.	<- Identify software name(s) or specify "As Required by Manufacturer".	
Enclosure/Housing:	29	Integral; Aluminum Enclosure.	<- Specify NEMA rating. Coordinate with Line 31.	
Mounting:	30	Integral; 316 S.S. Hardware.	<- Identify mounting as "Integral Mount", "Remote Panel Mount", or "Remote Wall Mount". Cc	
Area Classification:	31	Not Applicable	<- Identify area classification OR specify "Not Applicable". Refer to Area Classification Chart.	
Additional Features:	32	Electronic Filter to smooth signal variations.		

NOTES		
Function:	33	Ultrasonic Level Transmitter shall be a continuous liquid level measuring system which produces an output signal linear with level.
Installation:	34	Refer to Contract Drawing Installation Details and manufacturer's recommendations for installation.
Calibration:	35	Provide ISO Factory Calibration Certificate.
Keypad:	36	Provide keypad for system programming and configuration. Programming and configuration values shall be stored in EEPROM memory that does not require battery back-up.
	37	
	38	
	39	

MANUFACTURE		Provide products of one of the following, Or Equal:		
Manufacturer:	40	Endress Hauser	Rosemount	

13423 ATTACHMENT D - PRESSURE MEASUREMENT DATA SHEET

PRODUCT	**Pressure Transmitter**			SHEET 1	OF 1
PROJECT	NERT WEIR DEWATERING TREATMENT			SPEC. NO. 13423 Attachments	ATTACHMENT NO. E
TAG NO.		**PIT - 4010**	**Notes To Specifier:**		
Ref. Dwg. No.:	1	I-401	<- Specify Drawing Number where instrument is shown.		
PROCESS					
Location:	2	Central Water Treatment Plant	<- Specify Location of Instrument		
Service:	3	Plant Influent	<- Specify Equipment that Instrument Services		
Vessel / Line No.:	4	CS-RW-X	<- Specify Vessel/Line No. if applicable		
Fluid:	5	Surface Water with < 10% AP	<- Specify Process Fluid.		
Temp. Min/Max:	6	65 / 90 degrees F	<- Specify Process Fluid Temperature Range		
Press. Min/Max:	7	0 / 375 psi	<- Specify Process Fluid Pressure Range		
PERFORMANCE					
Range:	8	10-600 psi	<- Specify Sensor Range		
Accuracy:	9	±0.15% of calibrated span (includes effects of linearity, hysteresis, and repeatability).			
Temperature:	10	-20 to 180 °F; (See Notes, Line 35).			
Repeatability:	11	±0.05% of calibrated span.			
Damping:	12	Internal Adjustment.			
Hysteresis:	13	±0.05% of calibrated span.			
Stability:	14	Less than ±0.25% of Transmitter upper range limit (drift over 6 month period).			
Overrange Protec.:	15	Positive overrange protection: At least 1.25 times maximum span limit.			
SENSOR					
Type:	16	Pressure Gauge.			
Element:	17	Transducer.			
Diaphragm Seal:	18	(See Notes, Line 40).			
Capillary Tubing:	19	316 S.S. Capillary to extend from process connection to transmitter.	<- If remote mount sensor, than specify: "304 S.S." OR "316 S.S.". If integral mount, specify "Not require		
Mounting:	20	Process Conn. 2" Flange;Integral Mount to Transmitter.	<- Specify "Process Port Mount" if capillary tubing not required. Coordinate with line 19.		
Area Classification:	21	Not Applicable	<- Identify area classification OR specify "Not Applicable". Refer to Area Classification Chart.		
Additional Features:	22				
TRANSMITTER					
Type:	23	Solid state, 2-wire, Differential Capacitance or Resonant Wire Type Transmitter.	<- Specify: "Differential Capacitance" OR "Resonant Wire".		
Output:	24	4-20 mADC; (See Notes, Line 36).			
Power Supply:	25	24 VDC; Operates on power from receiver or remote power supply.			
Indication / Display:	26	Integral LCD Indication for Pressure in Engineering Units.			
Enclosure/Housing:	27	NEMA 4X; Epoxy painted; Die-cast low copper aluminum alloy housing; Covers threaded and seated on O-rings.	<- Specify NEMA rating, Body Material, AND O-ring Material (e.g. NEMA 4X; 316 S.S. Body; Buna-N O-r		
Mounting:	28	Pipe Stand Mount.	<- Specify: "316 S.S. Mounting Bracket", "Pipe Stand Mount", OR other mounting requirement.		
Connections:	29	Electrical Conn.: 1/2 inch NPT.			
Area Classification:	30	Not Applicable	<- Identify area classification OR specify "Not Applicable". Refer to Area Classification Chart.		
Additional Features:	31	Built-In Surge and RFI protection.			
NOTES					
General:	32	All wetted parts shall be compatible with the process fluid. Refer to Materials Compatibility Chart.			
Installation:	33	Refer to Contract Drawing Installation Details and manufacturer's recommendations for installation.			
Calibration:	34	Zero and Span (coarse & fine) adjustments in electronics compartment. Provide Zero Elevation and Suppression so that the extent of suppression plus the calibration span does not exceed the upper range limits of the sensor.			
Amb. Temp. Effect:	35	Total Error per 100 deg. F change between Ambient Temperature Limits: < ±1.0% transmitter range limit (max. span).			
Output:	36	Digital process variable signal superimposed on 4-20 mADC signal without compromising loop integrity.			
Shutoff Valve:	37	Provide a single shutoff valve at each process line tap to enable live process removal of transmitter. Provide Type 316 S.S. 3-valve manifold for shutoff and pressure equalization on differential pressure and flow measurement applications.			
Calibration Valve:	38	For each unit, provide an additional calibration valve port.			
Hand-held Unit:	39	Provide a hand held interface with keyboard and LED display for easy configuration and testing of transmitter.			
Diaphragm Seal:	40	A diaphragm seal is required for all mediums except air or potable water. Diaphragm material shall be compatible with the process fluid.			
	41				
MANUFACTURE		Provide products of one of the following, Or Equal:			
Manufacturer:	42	Endress Hauser	Rosemount	Siemens	

SPECIFICATION REVISION INDEX

Revision No.	Revision Date	Issued for	Signatures				
			Prepared By	Reviewed By	Project Engineer	Project Manager	Client
A	11/28/2016	60% Submittal			JG	STD	
B	1/27/2017	DRAFT 90% Submittal			JG	STD	
C	2/15/2017	75% Submittal			JG	STD	

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SECTION 13428

ANALYTICAL INSTRUMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Total Suspended Solids (TSS) Analyzer

1.02 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. See Attachments 13428, for analytical instrument specification data sheets.

PART 3 - EXECUTION

3.01 GENERAL

A. Examination, Installation, Field Quality Control, Demonstration: In accordance with Basic Instrumentation Requirements.

3.02 FIELD QUALITY CONTROL

A. Installation Check: The manufacturer shall provide the services of a factory-trained representative to check the installation of all equipment installed in this Section. The services shall be as noted in Section 01600.

1. Satisfactorily calibrate each analyzer and instruct the plant personnel in the operation and maintenance of each analyzer.

END OF SECTION

13428 ATTACHMENT A - ANALYTICAL INSTRUMENT DATA SHEET

PRODUCT	**Analyzer - Suspended Solids**		SHEET 1 OF 2	
PROJECT	NERT WEIR DEWATERING TREATMENT		SPEC. NO. 13428 Attachments	ATTACHMENT NO. A
TAG NO.	**AE / AIT - 2010**	**AE / AIT - 3010**	**AE / AIT - 4010**	
Ref. Dwg. No.: 1	I-201	I-301	I-401	
PROCESS				
Location: 2	Sunrise Mountain Pump Station	Historic Lateral Pump Station	Central Water Treatment Plant	
Service: 3	Influent	Influent	Influent	
Vessel / Line No.: 4	CS-RW-X (18")	CS-RW-X (18")	CS-RW-X (18")	
Fluid: 5	Surface Water with < 10% AP	Surface Water with < 10% AP	Surface Water with < 10% AP	
Temp. Min/Max: 6	65 / 90 degrees F	65 / 90 degrees F	65 / 90 degrees F	
Press. Min/Max: 7	0 / 30 psi	0 / 30 psi	0 / 300 psi	
PERFORMANCE				
Range: 8	1-10,000 mg/L.	1-10,000 mg/L.	1-10,000 mg/L.	
Accuracy: 9	±5% of Reading.	±5% of Reading.	±5% of Reading.	
Temperature: 10	Sensor: 32-122 deg. F; Transmitter: 14-122 deg. F.	Sensor: 32-122 deg. F; Transmitter: 14-122 deg. F.	Sensor: 32-122 deg. F; Transmitter: 14-122 deg. F.	
SENSOR				
Type: 11	Pipe Mounted Sensor.	Pipe Mounted Sensor.	Pipe Mounted Sensor.	
Element: 12	As Required.	As Required.	As Required.	
Enclosure/Housing: 13	Molded polymer body or S.S.	Molded polymer body or S.S.	Molded polymer body or S.S.	
Mounting: 14	S.S. Mounting Brackets/Hardware. Pipe mounting system for applicable pipe diameter	S.S. Mounting Brackets/Hardware. Pipe mounting system for applicable pipe diameter	S.S. Mounting Brackets/Hardware. Pipe mounting system for applicable pipe diameter	
Commun. Cable: 15	Interconnecting cable to Transmitter; Length as Required.	Interconnecting cable to Transmitter; Length as Required.	Interconnecting cable to Transmitter; Length as Required.	
Area Classification: 16	Not Applicable	Not Applicable	Not Applicable	
Additional Features: 17				
TRANSMITTER				
Type: 18	Analyzer/Transmitter.	Analyzer/Transmitter.	Analyzer/Transmitter.	
Output: 19	4-20 mADC.	4-20 mADC.	4-20 mADC.	
Power Supply: 20	120 VAC, 60 Hz.	120 VAC, 60 Hz.	120 VAC, 60 Hz.	
Relays: 21	As Required.	As Required.	As Required.	
Indication / Display: 22	LCD; Suspended solids indication & menu screens for program/calibration parameters.	LCD; Suspended solids indication & menu screens for program/calibration parameters.	LCD; Suspended solids indication & menu screens for program/calibration parameters.	
Enclosure/Housing: 23	Transparent viewing window.	Transparent viewing window.	Transparent viewing window.	
Mounting: 24	S.S. Mounting Brackets/Hardware.	S.S. Mounting Brackets/Hardware.	S.S. Mounting Brackets/Hardware.	
Area Classification: 25	Not Applicable	Not Applicable	Not Applicable	
Additional Features: 26	Keypad (See Notes, Line 30).	Keypad (See Notes, Line 30).	Keypad (See Notes, Line 30).	
NOTES				
Function: 27	Continuous monitoring system shall consist of a pipe mounted sensor and an analyzer/transmitter designed to measure the suspended solids concentration in wastewater applications.			
Materials: 28	All wetted parts shall be compatible with the process fluid. Refer to Materials Compatibility Chart.			
Installation: 29	Refer to Contract Drawing Installation Details and manufacturer's recommendations for installation.			
Keypad: 30	Front of panel, membrane sealed keypad for display control and transmitter function control testing and calibration.			
31	Sensor and mounting hardware shall be capable of accurate measurement within provided pressure ratings listed (line 7). Sensor shall be side mounted in order to ensure submersion and an accurate measurement.			
32				
33				
34				
35				
36				
37				
MANUFACTURE	Provide products of one of the following, Or Equal:			
Manufacturer: 38	Endress Hauser	Hach		

13428 ATTACHMENT B - ANALYTICAL INSTRUMENT DATA SHEET

PRODUCT	**Analyzer - Suspended Solids**		SHEET 2 OF 2	
PROJECT	NERT WEIR DEWATERING TREATMENT		SPEC. NO. 13428 Attachments	ATTACHMENT NO. B
TAG NO.	**AE / AIT - 6010**	**AE / AIT - 7010**	**AE / AIT - 8060**	
Ref. Dwg. No.: 1	I-601	I-701	I-806	
PROCESS				
Location: 2	Central Water Treatment Plant	Central Water Treatment Plant	Central Water Treatment Plant	
Service: 3	Multimedia Filter Header	ION Exchange Feed Header	Treated Water Discharge	
Vessel / Line No.: 4	CS-CE-X (20")	CS-FW-X (20")	CS-TW-X (18")	
Fluid: 5	Surface Water with < 10% AP	Surface Water with < 10% AP	Surface Water with < 10% AP	
Temp. Min/Max: 6	65 / 90 degrees F	65 / 90 degrees F	65 / 90 degrees F	
Press. Min/Max: 7	0 / 300 psi	0 / 300 psi	0 / 300 psi	
PERFORMANCE				
Range: 8	1-10,000 mg/L.	1-10,000 mg/L.	1-10,000 mg/L.	
Accuracy: 9	±5% of Reading.	±5% of Reading.	±5% of Reading.	
Temperature: 10	Sensor: 32-122 deg. F; Transmitter: 14-122 deg. F.	Sensor: 32-122 deg. F; Transmitter: 14-122 deg. F.	Sensor: 32-122 deg. F; Transmitter: 14-122 deg. F.	
SENSOR				
Type: 11	Pipe Mounted Sensor.	Pipe Mounted Sensor.	Pipe Mounted Sensor.	
Element: 12	As Required.	As Required.	As Required.	
Enclosure/Housing: 13	Molded polymer body or S.S.	Molded polymer body or S.S.	Molded polymer body or S.S.	
Mounting: 14	S.S. Mounting Brackets/Hardware. Pipe mounting system for applicable pipe diameter	S.S. Mounting Brackets/Hardware. Pipe mounting system for applicable pipe diameter	S.S. Mounting Brackets/Hardware. Pipe mounting system for applicable pipe diameter	
Commun. Cable: 15	Interconnecting cable to Transmitter; Length as Required.	Interconnecting cable to Transmitter; Length as Required.	Interconnecting cable to Transmitter; Length as Required.	
Area Classification: 16	Not Applicable	Not Applicable	Not Applicable	
Additional Features: 17				
TRANSMITTER				
Type: 18	Analyzer/Transmitter.	Analyzer/Transmitter.	Analyzer/Transmitter.	
Output: 19	4-20 mADC.	4-20 mADC.	4-20 mADC.	
Power Supply: 20	120 VAC, 60 Hz.	120 VAC, 60 Hz.	120 VAC, 60 Hz.	
Relays: 21	As Required.	As Required.	As Required.	
Indication / Display: 22	LCD; Suspended solids indication & menu screens for program/calibration parameters.	LCD; Suspended solids indication & menu screens for program/calibration parameters.	LCD; Suspended solids indication & menu screens for program/calibration parameters.	
Enclosure/Housing: 23	Transparent viewing window.	Transparent viewing window.	Transparent viewing window.	
Mounting: 24	S.S. Mounting Brackets/Hardware.	S.S. Mounting Brackets/Hardware.	S.S. Mounting Brackets/Hardware.	
Area Classification: 25	Not Applicable	Not Applicable	Not Applicable	
Additional Features: 26	Keypad (See Notes, Line 30).	Keypad (See Notes, Line 30).	Keypad (See Notes, Line 30).	
NOTES				
Function: 27	Continuous monitoring system shall consist of a pipe mounted sensor and an analyzer/transmitter designed to measure the suspended solids concentration in wastewater applications.			
Materials: 28	All wetted parts shall be compatible with the process fluid. Refer to Materials Compatibility Chart.			
Installation: 29	Refer to Contract Drawing Installation Details and manufacturer's recommendations for installation.			
Keypad: 30	Front of panel, membrane sealed keypad for display control and transmitter function control testing and calibration.			
31	Sensor and mounting hardware shall be capable of accurate measurement within provided pressure ratings listed (line 7). Sensor shall be side mounted in order to ensure submersion and an accurate measurement.			
32				
33				
34				
35				
36				
37				
MANUFACTURE	Provide products of one of the following, Or Equal:			
Manufacturer: 38	Endress Hauser	Hach		

SPECIFICATION REVISION INDEX

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B	1/27/2017	DRAFT 90% Submittal			JG	STD	
C	2/15/2017	75% Submittal			JG	STD	

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SECTION 13450

PROGRAMMABLE LOGIC CONTROLLERS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Programmable Logic Controller (PLC):

a. Central processing unit.
b. Process input/output.

2. Operator Interface Panel (OIP)

B. Related Work Described Elsewhere:

1. Basic Instrumentation, Monitoring, and Control Requirements: Section 13410.

C. System will be configured to communicate via fiber optic to existing facility SCADA network.

1.02 SUBMITTALS

A. Shop Drawings: Submit in accordance with Division 1, Shop Drawings covering the items included under this Section.

B. Contract closeout: Submit in accordance with Division 1.

1.03 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer shall be regularly engaged in manufacturing equipment complying with requirements of these Specifications.

1.04 WARRANTY

A. Special Warranty: CONSTRUCTION MANAGER shall purchase 1-year upgrade and technical support warranties for all software purchased under this Section. As part of these services, there shall be no intermediaries. They shall be between CONSTRUCTION MANAGER and OEM.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which shall be incorporated in Work include:

1. Programmable Logic Controller (PLC):

a. Allen Bradley CompactLogix

2. PLC Program Development Software:

a. Allen Bradley RSLogix 5000

3. Operator Interface Panel (OIP)

a. Allen Bradley Panel View Plus 1500

4. OIP Development Software

a. Rockwell Factory Talk View ME

2.02 PROGRAMMABLE LOGIC CONTROLLER (PLC)

A. PLCs shall be general purpose process data acquisition and control devices. The PLC shall be microprocessor-based driven by a stored program, and shall be compatible with and work in harmony with remote devices specified herein.

B. Central Processing Unit:

1. Each central processing unit shall consist of a 16-bit parallel processor with scan not to exceed 150 milliseconds for all program steps and input/output time servicing. The processor(s) shall have memory capacity as shown on Drawings.

2. The system shall contain a general purpose set of instructions. Watchdog timer protection shall be provided. The processor shall have self-diagnostic capabilities. Each processor shall be supplied with adequate random access memory to support tasks covered in these Specifications. Memory shall be semiconductor with on-board lithium battery backup power for at least 4 months prime source outage.

3. PLCs shall have permanently installed system software for process input/output servicing, PLC intercommunications, LAN communication, diagnostics, and process control. The basic model for PLC operations shall be "ladder diagram."

4. Data elements shall be grouped according to type or function into registers or files. Provide a consistent addressing structure for PLC and external machines to reference data elements. The following basic data types shall be provided:

    a. Input.

    b. Output.

    c. Bit.

    d. Integer (16-bit).

    e. Timer.

    f. Counter.

    g. Character (ASCII).

5. Process Control: Program elements shall be provided to execute the following kinds of actions:

    a. Basic Relay Logic.

    b. Timers: On-delay, Off-delay, Retentive.

    c. Counters: Count-up, Count-down.

    d. Arithmetic: Add, Subtract, Multiply, Divide, Square Root.

    e. Logic: Negate, And, Or, Exclusive Or.

    f. Conditionals.

    g. Data transition.

    h. One-shot.

    i. Stepper Switches (sequencers).

    j. Branching Instructions.

    k. Subroutines.

    l. File Instructions.

    m. Analog PID Control:

1) ISA Algorithm.
2) Independent Gain Algorithm.
3) Ratio Control.

6. Process Input/Output: Complete process input/output assemblies shall be provided. Process input/output shall consist of modules of each major function to be monitored or controlled. Each input/output module shall plug into processor frame assembly and be interconnected to input/output terminal strip cable connections.

    a. Remote input/output modules shall be separately housed as shown on Drawings. Where remote modules are used, they shall communicate with PLC via fiber optic cable unless indicated otherwise in the drawings.

7. Analog Input: Analog inputs to system shall be in form of differential (non-grounded) direct current voltages. Input circuitry shall be high-impedance such that external sensing circuits will not be adulterated by presence of this equipment. In all cases this equipment shall be passive with respect to analog sensing circuits. External power supplies shall be provided as necessary. Provide a minimum of 20% spare analog inputs.

    a. Milliampere loops shall be sensed in concert with precision resistors appropriately sized. Such resistors shall be applied at termination point in a way that input card removal does not affect loop continuity. Each analog signal shall be connected to system via a barrier-type terminal strip.

    b. Input impedance shall be a minimum of 10 megohms and common mode rejection shall be 120 dB or better. Accuracy shall by plus 0.1 percent full scale and resolution shall be 25 percent. Analog to digital conversion shall yield a signed 12-bit integer. Provide 8 inputs per card.

8. Analog Outputs: Control signals in form of 4-20 mA analog signals into 500 ohms shall be provided. Each analog output shall be provided on a barrier-type terminal strip. Provide a minimum of 20% spare analog outputs.

    a. Analog output modules shall be provided to interface each output to appropriate terminal strip. Each output shall be continually maintained by a sample and hold circuit with a drift rate no greater than 1 percent in 12 hours. Digital to analog conversion shall accept signed 12-bit integers. Provide 4 outputs minimum per card.

9. Discrete Inputs: Discrete inputs to be monitored shall consist of isolated dry contract closures and 120 VAC inputs as shown. Barrier-type terminal strips capable of terminating inputs shall be provided. Provide a minimum of 20% spare discrete inputs.

    a. A discrete input circuit board shall be equipped with a photo isolation for each discrete input. Noise and contact bounce less than 20 milliseconds shall be rejected. Provide 16 inputs per card.

10. Discrete Outputs: Control signals in form of discrete outputs shall be provided. Each discrete control signal shall be provided on a barrier-type terminal strip. They shall make use of relays or zero-angle fired triacs having a capability of at least 2 amps. They shall include any necessary arc suppression or other conditioning circuitry to ensure their proper operation in conjunction with field elements specified. Provide a minimum of 20% spare discrete outputs.

    a. Each output shall be fused and shall be equipped with a status indicator. A blown fuse indicator shall also be provided.

    b. Outputs used to control devices external to enclosure in which module is located shall be isolated type, allowing use of a different external 120 VAC power source for each output. Outputs used to control devices within enclosure in which module is located need not be isolated. Provide 16 outputs per card.

    c. Outputs used to control devices external to enclosure in which module is located shall be relay type. Outputs used to control devices within enclosure in which module is located may be zero-angle fired triacs where compatible with devices.

    d. Outputs used to interface to alarm auto dial unit shall be relay type and for use with 24 VDC power.

11. Rack Configuration: Provide I/O to meet requirements shown on Drawings, plus 20% spare I/O of each type used. I/O assignments must not put more than 50% of similar equipment on same card to prevent catastrophic failures based on loss of 1 card. Equipment rack layout must allow for addition of 20 percent more cards per rack; minimum space 2 slots. This requirement is totaled for each rack; it in not based on overall network.

2.03 DATA HIGHWAYS

A. Link the PLC's, Operator Interface Computers and associated equipment into an integrated network. Programmable Logic Controllers (PLCs) shall be equipped with communication channels as depicted on Drawings.

B. Plant-wide Networks:

1. PLCs shall include an Ethernet (Profinet) and Profibus communication adapter ports where shown on Drawings. The selected messaging protocol for this port shall be Profinet and shall provide high throughput with error detection and correction. Reliability shall be achieved through use of appropriate check sums, parity checking, redundant messages, and acknowledgment/rejection of messages.

2. The network shall operate at a speed of 10M bits per second or faster. Network protocol shall be carrier sense multiple access/collision detection (CSMA/CD) in compliance with

IEEE 802.3. Alternate protocols conforming to IEEE 802 may be used only upon written permission granted by CONSTRUCTION MANAGER.

C. Fiber-Optic Converters:

1. Provide fiber-optic communication compatible with PLC hardware and communication protocols. Converters shall be stand-alone or rack-mounted as shown on Drawings. Converters shall use multimode fiber and Type ST mating connectors. Transmit launch power shall be -15 dbm and receive sensitivity shall be -32 dbm.

D. Provide cables as required to interconnect each network component. Provide all cables and connectors for programmable products. Cables shall be installed in conduit and/or underground duct under Division 16. Cables shall be shipped to Site in bulk with connectors not attached. Cables shall be rated -40 degrees Fahrenheit to 158 degrees Fahrenheit.

2.04 PROGRAM DEVELOPMENT SOFTWARE

A. Licensed copies of RSLogix5000 PLC program development software are to be supplied and registered to CONSTRUCTION MANAGER. Development software shall be the latest service pack supported by Siemens and compatible with specified controllers.

B. Licensed copies of Rockwell Factory Talk View ME (OIP Software), Version 8.0 or higher are to be supplied and registered to owner.

PART 3 - EXECUTION

3.01 Examination, Installation, Field Quality Control, Demonstration: In accordance with Section 13410: Basic Instrumentation, Monitoring and Control Requirements.

END OF SECTION

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SPECIFICATION REVISION INDEX

Revision No.	Revision Date	Issued for	Signatures				
			Prepared By	Reviewed By	Project Engineer	Project Manager	Client
A	11/28/2016	60% Submittal			JG	STD	
B	2/15/2017	75% Submittal			JG	STD	

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SECTION 13700

PROCESS CONTROL SOFTWARE PROGRAMMING

PART 1 - GENERAL

1.1 SUMMARY

A. Work includes programming, testing, and installation of software required for a complete and fully operational control system. Principal segments of Work include, but are not limited to, programmable logic controller ladder logic, data collection, supervisory control, operator interface panels, SCADA HMI workstations, process data management, and plant administrative/management reports.

1.2 SYSTEM DESCRIPTION

A. This section provides functional descriptions of the PLC and computer software requirements for the Instrumentation and Control System as indicated on the drawings. These descriptions are intended to provide an overview of the operating concept of the plant process equipment rather than describing in detail every operating feature or interlock.

B. See section 16050 - Treatment Process Operating Procedures, for system process control and display descriptions in addition to the IO and functions indicated on the drawings.

1.3 ACTION SUBMITTALS

A. Format: Text and picture documents shall be provided in color to insure the accuracy of each item. No black and white copies will be accepted. The colors used in the printed submittal shall accurately depict the colors and shapes proposed for use on the final system. In addition to paper copies, CONTRACTOR shall supply editable electronic files in their native format.

B. Shop Drawings: Submit in accordance with contract documents, Shop Drawings and product data for products provided under this Section.

1. Detailed functional descriptions of all software modules specified and furnished as part of INTEGRATOR'S standard system. The descriptions shall be identified with the applicable specification paragraph from this Section. The document shall be submitted for review and approval before software configuration commences. The document should provide text based narrative describing each piece of equipment's control scheme. The document should include HMI graphic screens diagrams (based on process P&ID) and control overlays (pop-ups) and animation plan. The text should cover Remote\Auto and Remote\Manual conditions along with Local\Auto and Local\Manual control schemes. Permissive, interlocks, discrete alarms, analog alarms, totalized values, equipment run timers, and historical

trended values shall be stated for each process area. Instructions shall be short, easy-to-understand directions specifically written for this project describing various components functionality.

2. Software Programs: One fully annotated printed copy of program prior to factory test. In addition, provide required number of copies of latest revisions of program at time of acceptance by CONSTRUCTION MANAGER. Submittal of printouts, listings, and screen images shall be supplied on paper (hard copy). With concurrence of CONSTRUCTION MANAGER, electronic copies may be supplied in addition to printed copies as a matter of convenience. Format of electronic media shall be as mutually agreed with OWNER.

3. Programmable Logic Controllers: Submits lists of input and output assignments, data file structures used, and internal data points. Show points used to communicate with between PLCs and the operator interface and data collection segments. Include complete, fully annotated ladder logic diagrams complete with cross-reference listings.

4. Operator Interface and Supervisory Control: Submit "screen dump" images of each proposed operator interface screen and images of historical trending. Describe color schema, mouse button use, function key controls and communication protocol with PLCs. Provide a flow diagram showing screen navigation. Show sample event and alarm log outputs.

5. Data Management and Reporting: Describe data collection, and reporting scenarios. Describe data file storage management including backup and archive operations.

6. Security; Document every user name and password required for any new or modified control equipment. This document should be hand delivered to the CONSTRUCTION MANAGER, along with all backups and configuration files.

C. Software Configuration Standards and Conventions

1. Software Configuration Standards and Conventions document shall be prepared and submitted by the INTEGRATOR. The document shall be submitted for review and approval before software configuration commences. Before submitting the initial draft document, the INTEGRATOR shall meet with the Engineer and/or Owner to review any of the Owner’s existing standards and conventions.

   a. Operator Interface Software; This section shall describe and define such items as proposed graphic display process line colors/representations; color standards for “on”, “off”, “opened”, “closed”, and “alarm” conditions; alarm handling conventions; how items will be selected for control; methods for navigation between displays; address usage/naming conventions; file storage and space management; trending; and security setup.

b. Logic Controller Programming; This section shall describe and define such items as proposed ladder logic format; function blocks; data blocks; tag and alias structure/naming standards; interlocks for manual and auto logic; series, parallel, seal-in, debug bits, latch and un-latch standards; pump, valve, and motor standard logic; alarming, data buffering, signal scaling (including dead band, minimum and maximum limits), maintenance modes, out-of-service modes, flow tantalizers, and run time counters; messaging, error checking, time syncing, and fault handling.

2. The Software Configuration Standards and Conventions document shall include both the Siemens WinCC Version 7.2 database and the WinCC Comfort (TIA Portal V11 SP2 or higher) interface systems.

D. In addition to submitting the documents above for review, an updated version of the documents shall be submitted as part of the O&M Manuals. The document shall be revised to document any additional changes to control scheme that are established throughout the project process.

E. Factory Test Procedure

1. Documentation containing factory test methods and procedures.

F. Site Acceptance Test (SAT)

1. The site acceptance test procedure; it shall refer to the actions and expected results to demonstrate that the control system performs in accordance with the sequence of control. Include a list of the equipment to be used during the testing plus manufacturer's name, model number, equipment function, the date of the latest calibration and the results of the latest calibration.

G. Operator Training Manuals

1. Training manuals shall be submitted twenty-one (21) days before Preliminary Operator Training is scheduled. After approval a copy of the training manual for each trainee plus two additional copies shall be delivered to the ENGINEER. Manuals shall include an agenda, the defined objectives for each lesson, and a detailed description of the subject matter for each lesson. Furnish audiovisual equipment and other training supplies and materials. Copies of the audiovisuals shall be delivered with the printed training manuals. The OWNER reserves the right to videotape training sessions for later use.

2. Submit training schedule for approval. Approval of the Contractor's training schedule shall be obtained from the ENGINEER at least 10 days before the training.

1.4 INFORMATIONAL SUBMITTALS

A. Test Reports

1. Factory Acceptance Test (FAT)
2. Site Acceptance Test (SAT)
3. Network Condition

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Manuals: operation and maintenance manuals for items included under this Section.

1. Six complete copies of operating instructions outlining the required for the control system.

2. Instructions shall be short, easy-to-understand step-by-step procedures specifically written for this Project describing various possible methods of operating equipment with flow diagram (this should include system startup, operation and shutdown). Instructions shall include procedures for tests required, adjustments to be made, and safety precautions to be taken with equipment. These documents are to be submitted to ENGINEER's office.

3. Troubleshooting instructions shall be included identifying common conditions and there resolutions. The initial list of topics shall be submitted to the ENGINEER before FAT. The INTEGRATOR shall include additional time to incorporate new topics from ENGINEER 60 days after SAT.

4. Manuals shall include program listings, point/address lists, cross-reference listings, screen captures, data entry forms, and sample reports.

5. Manuals shall include instructions for program users and instructions for maintenance programmers, including alarm conditions and possible corrective actions, special code/scripts/configurations if used, backup and recovery information.

6. Include in the instructions layout, the manufacturer's name, model number, service manual, parts list and a brief description of all software and their basic operating features.

1.6 QUALITY ASSURANCE

A. Manufacturer’s Qualifications: Firms regularly engaged in manufacture of equipment, of types and sizes required, and whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards:

1. National Electric Code.
2. Applicable State and local requirements.
3. American National Electrical Manufacturers Association.
4. American Water Works Association.
5. International Electrotechnical Commission
6. International Society of Automation.
7. Open Modular Architecture Controls (OMAC) Users Group.

C. Items covered by this Section are designated as undelivered specifically manufactured equipment for which associated progress payments will be made in accordance with this Specification.

D. Proposed graphic screens report formats, and security shall be reviewed with the Owner and Engineer throughout the configuration process. The INTEGRATOR'S programming personnel shall attend the initial review meeting. A second review meeting, held at approximately 50 percent completion, but prior to the factory acceptance test, shall also be held. Both meetings shall be held at project site.

E. To ensure timely performance and conformance with Specifications, Project meetings shall be held at CONSTRUCTION MANAGER facility once every week during course of Project. Cost of such meetings shall be included.

F. Calibration Equipment and Testing Apparatus: Equipment supplier shall have available test and calibration equipment for factory panel tests, installation, start-up, service contract, and maintenance or troubleshooting purposes. The equipment required for these tests is as follows:

1. One – Programming terminal with software to configure programming equipment, and to run graphical software.

2. One – Digital Multimeter with an accuracy of plus or minus 0.1 percent.

3. One – Signal calibrator for analog signals.

PART 2 - PRODUCTS

2.1 SOFTWARE SERVICES

A. Software services shall provide by the following:

1. DMC Denver, 1860 Blake Street, Denver, CO (303) 223-1801

2. Champion Technologies, 400 W ironwood Drive, Salt Lake City UT (801) 972-1868

3. Corso Systems, 125 E 21st St #109, Chicago, IL 60616

B. Software services include program development, testing, documentation, and Work necessary to implement a complete and fully operating system as shown on Drawings and/or as specified. Provide programming to implement required functions and features.

C. Work requires coordination with concurrent program development for PLCs, Operator Interfaces, Management Reports, and Data Collection. Include PLC error detection logic for communications failures, faults, internal faults, and time outs. Communicate PLC error conditions to Operator Interface for logging and reporting.

D. SOFTWARE FUNCTIONAL REQUIREMENTS. General functional requirements for system configuration are indicated on the drawings and described in the specifications. The information presented herein and indicated on the drawings illustrates the general functional intent of the system, and may not be sufficient to fully configure the system. The INTEGRATOR shall be responsible for determining what additional information may be required to complete the configuration tasks, and for obtaining this information from the Engineer or the Owner.

E. Control System Database. The control system database shall be developed and configured by the INTEGRATOR. The INTEGRATOR shall enter information obtainable from the Contract Documents into the database prior to soliciting input from the Engineer and the Owner. The INTEGRATOR shall determine the need for any "pseudo" database points and shall ascertain and enter all information needed to define these points. The EQUIPMENT SUPPPLIER is responsible for entering all information associated with each point. This includes but is not limited to, descriptions, engineering units, associated displays, areas, security, etc. All fields associated with each database point must be completely filled out accurately. Database shall follow ISA standards including ANSI/ISA-506.01-2007.

F. Graphic Screen Displays. The INTEGRATOR shall be responsible for developing and configuring the custom graphic displays. Each piece of major process equipment that is monitored by the control system shall be displayed on one or more graphic screen. Graphic screens shall be representations of the equipment and piping. The screens must accurately show all devices and equipment that is part of the control loops. These items must be done in accordance to the Configuration Standards and Conventions as described earlier in this section. The requirement for alarm and/or event displays shall also be provided and proven functional prior to acceptance of the system. A means of capturing and printing of all graphic screens shall also be included for SCADA HMI workstations. The WinCC Version 7.2 software program must be capable of printing the screen in a black and white (using gray scale) or color format. This program must be accessible from all terminals provided under this contract. The black and white printing shall be done in a manner in which the use of the black background is not represented in the printout. This is done to keep the utilization of ink cartridge and toner cartridge to a minimum.

G. Report Formats. Report formats shall be developed and programmed by the INTEGRATOR using tag names defined in the database creation. New reports attributable to work done under this contract shall be provided as requested by the

OWNER. All reports will follow the OWNER'S established formatting. Reports shall be produced within 30 seconds from operator request.

H. Alarming shall utilize the EEMUA 191, ISA-18.1, and RP77.60.02-2000 standards for structure, implementation, and occurrence. The time required for the operator interface panel (Siemens TP1500) to display an alarm shall not exceed 20 seconds.

I. Communication between PLCs, Operator Interface, and Data Collection shall be on an exception basis. When reportable changes in process state occur, such as alarm assertion, return to normal or analog value out of dead band, report event to PLC that communicates with Operator Interface and Data Collection. This PLC shall maintain data tables current with all process inputs and outputs. Organize data to be transferred into contiguous blocks of information using bit-mapped and integer tables. Employ a "watchdog" timer for each remote PLC and poll that PLC if no message has been received in a reasonable amount of time notify an operator with an alarm. Accept Operator Interface directives for setpoint changes and hand switches.

J. Database shall be designed to limit data growth rate. Database shall not exceed 1 GB a year, INTEGRATOR shall monitor database for 3 months after all points are configured. Database shall have a 98% availability (98% of the system data will be stored to the database).

2.2 PROGRAMMABLE CONTROLLER LOGIC

A. Develop programs for execution on PLC using Siemens Step 7 Version 5.5. Logic shall perform functions required to control processes and equipment as shown on Drawings and/or as specified in this section. Develop complete cross-references for ladder logic and complete input/output listings.

B. Operating System

1. The PLC shall maintain a point database in its memory that includes all parameters, constraints and the latest value or status of all points connected to the PLC. Execution of the PLC application programs shall use the data in memory resident files. All code shall be based on ladder logic diagrams with a mix of function blocks, sequential function charts and text to supplement programming. Programming methods and interactions shall be based on IEC 61131-3. Combinations of the programming methods are allowed within a single controller. The operating system shall allow loading of software locally or from the central station. It shall also support data entry and diagnostics using an operator interface panel attached directly to the PLC.

a. Startup: The PLC shall have startup software that causes automatic commencement of operation without human intervention, including startup of all connected I/O functions. A PLC restart program based on detection of power failure at the PLC shall be included in the PLC software. The restart

program shall include start time delays between successive commands to prevent demand surges or overload trips.

b. Failure Mode: Upon failure for any reason, the PLC shall perform an orderly shutdown and force all PLC outputs to a predetermined (failure mode) state, consistent with the failure modes shown and the associated control device.

C. Functions

1. Analog Monitoring

a. The system shall measure and transmit all analog values including calculated analog points.

2. Logic (Virtual)

a. Logic (virtual) points shall be software points entered in the point database which are not directly associated with a physical I/O function. Logic (virtual) points shall be analog or digital points created by calculation from any combination of digital and analog points, or other data having all the properties of real points, including alarms, without the associated hardware. Logic (virtual) points shall be defined or calculated and entered into the database. The calculated analog point shall have point identification in the same format as any other analog point.

3. State Variables

a. If an analog point represents more than two (up to 8) specific states, each state shall be nameable. For example, a level sensor shall be displayed at its measured engineering units plus a state variable with named states usable in programs or for display such as low alarm/low/normal/high/high alarm.

4. Analog Totalization

a. Any analog point shall be operator assignable to the totalization program. Up to eight analog values shall be totalized within a selectable time period.

5. Trending

a. Any analog or calculated point shall be operator assignable to the trend program. Up to eight points shall be sampled at individually assigned intervals, selectable between 1 minute and 2 hours. A minimum of the most recent 128 samples of each trended point shall be stored. The sample intervals shall be able to be defined, modified, or deleted online.

D. Alarm Processing

1. Digital Alarms

    a. Digital alarms are those abnormal conditions indicated by DIs as specified and shown. The system shall automatically suppress analog alarm reporting associated with a digital point when that point is turned off.

2. Analog Alarms

    a. Analog alarms are those conditions higher or lower than a defined value, as measured by an AI. Analog readings shall be compared to predefined high and low limits, and alarmed each time a value enters or returns from a limit condition. Unique high and low limits shall be assigned to each analog point in the system. In control point adjustment (CPA) applications, key the limit to a finite deviation traveling with the setpoint. The system shall automatically suppress analog alarm reporting associated with an analog point when that analog point is turned off.

    b. Each analog point will have a low alarm, low warning, normal, high warning, and high alarm. All alarms may be turned off or On from the OIP or HMI.

E. Constraints

1. Equipment Constraints Definitions

    a. Each control point in the database shall have PLC resident constraints defined and entered by the INTEGRATOR, including as applicable: maximum starts (cycles) per hour; minimum off time; minimum on time; high limit (value in engineering units); and low limit (value in engineering units).

F. Constraints Checks

1. All control devices connected to the system shall have the PLC constraints checked and passed before each command is issued. Each command point shall have unique constraints assigned. High and low "reasonableness" values or one differential "rate-of-change" value shall be assigned to each AI. Each individual point shall be capable of being selectively disabled by the operator from the central station.

G. Control Sequences and Control Loops

1. Specific functions to be implemented are defined in individual system control sequences and database tables shown on the drawings, and shall include, as applicable, the following functions: PI control shall provide proportional control and proportional plus integral control; two position control shall provide control for a two state device by comparing a set point against a process variable and an established dead band; floating point control shall exercise control when an error signal exceeds a selected dead band, and shall maintain control until the error is within the dead band limits; signal selection shall allow the selection of the highest

or lowest analog value from a group of analog values as the basis of control and shall include the ability to cascade analog values so that large numbers of inputs can be reduced to one or two outputs; signal averaging shall allow the mathematical calculation of the average analog value from a group of analog values as the basis of control and shall include the ability to "weight" the individual analog values so that the function output can be biased as necessary to achieve proper control; reset function shall develop an AO based on up to two AIs and one operator specified reset schedule.

2. PIDE Basic Loop Control

    a. Standard software algorithms shall be available to perform regulatory control functions, and these shall have easily configurable parameters.

    b. Basic loop control should be supported by the system via open loop tuning. Enhanced Proportional, Integral, Derivative (PIDE) control loops are supported through the Function Block Diagram and Structured Text control functions. These control functions can be used to create continuous and batch process PIDE control loops. Online editing permits changes to control loop strategies while they are operating.

    c. It shall be possible to put any individual control loop in a manual; automatic, or cascade mode. In cascade, it shall be possible to configure remote setpoints from other regulatory controllers or from other control blocks.

    d. There shall be bumpless transfer between all control modes, and windup protection shall be provided. Control blocks shall be able to perform automatic mode switching based on external or internal logic inputs.

3. PIDE Integrated Auto-Tune

    a. An integrated PID auto-tuner should be built into the PIDE instruction used in the function block language. Because the PIDE auto-tuning is built into the system controllers, auto-tuning can be performed from any operator workstation.

        1) Applicable to processes with slow and fast dynamics
        2) Used with self-regulating and integrating processes
        3) Immune to noise and process load disturbances
        4) Can be accessed directly from the controller

    b. The PID auto-tuning facility shall employ an easy-to-use graphical interface with a setup “wizard“(similar to Microsoft Excel®) to assist engineers and technicians who are unfamiliar with the tool.

4. PIDE Optimized Auto-Tune

a. The system shall provide advanced open and closed loop tuning and analysis by providing PID control loop optimization without additional programming.

b. Control loop process models can be automatically developed allowing users to analyze and simulate current operating conditions. Knowing the dynamics of the process model, advanced analysis tools can be applied to diagnose PID loop disturbances and suggest optimal proportional, integral, derivative and filtering values. These new values can be tested prior to downloading to the process allowing for the prediction of the new loop response and comparison of improvements with the current settings.

c. An off-line modeling tool should be available so archived process data can be used to perform loop analysis. Using real data off-line allows experimentation with new settings without compromising production.

H. Command Priorities

1. A scheme of priority levels shall be provided to prevent interaction of a command of low priority with a command of higher priority. Override commands entered by the operator shall have higher priority than those emanating from applications programs.

2.3 DEVELOPMENT SOFTWARE (OIP)

A. All development of the software configuration shall be performed using hardware and the system software owned by the INTEGRATOR. It is intended that the INTEGRATOR to use their own WinCC application development software for OIP screen development and for all related configuration work.

2.4 OPERATOR INTERFACE (LOCAL OPERATOR TOUCH PANEL)

A. Operator Interface programs provide graphic representation of local processes and control over machinery.

B. Screens shall include equipment status (On\Off\Opened\Closed) indications. Include analog instruments such as indicators, manual loading stations, controllers, etc., as shown.

C. Graphical Operations

1. Display Information

a. The SCADA HMI software shall display information necessary to support all requirements specified, including: operator commands; alarm notification; system graphics as specified and as shown, incorporating dynamic data; and curve plotting.

2. System Graphics Implementation

a. System graphics displays shall be hierarchical displays which integrate dynamic data into the display. System graphics shall reflect actual system configuration. Each system schematic shall be included as a separate display. Different colors, textures, and use of inverted video shall be used for various components and dynamic data. The displays shall include standard and/or custom symbols. Data associated with a display shall be updated within 5 seconds of the digital status change or the analog change in excess of the analog change differential. Any dynamic data which is not current, due to PLC communications failure, PLC failure, or point out of service, shall be highlighted or flagged. The INTEGRATOR shall develop a minimum of 8 process screens which depict the major equipment such as storage tanks, tank levels, major interconnect piping, pressures, flows, and status of equipment.

3. Trending

a. Provide on-screen trending displays that are user definable that operate from either previously collected historical trend groups (named file) or from a group of real-time variables. Provide facilities for user selection of colors, time (horizontal), and measurement (vertical) scales. Accommodate real-time sampling intervals as short as 1 second. Real-time trends shall show alarm setpoints. Historical trend displays shall have time-scale panning controls.

4. System Menus and Displays

a. The user shall be able to call up the following displays by dedicated function key, pull down menu or by icon and shall be able to page forward and backward on linked multiple page displays. The system menu and index displays shall also contain icons which can be used to call up subsequent displays.

b. System Menu (list of all graphics and menus).

1) Index (list of all PLCs).
2) Alarm Summary (list of all uncleared alarms).

3) Abnormal Summary (list of all devices not in normal state; keeps track of alarm conditions which have been cleared).
4) Data Communications Summary (listing of availability for each communication channel, by statistically processing the number of transmission errors, outages, and other abnormal conditions for each channel).

c. Navigation to any system graphics shall be no more than three push buttons away from any other screen.

D. Command Function

1. Command Input (Buttons)

a. Command buttons shall utilize full words and acronyms selected to allow operators to use the system without extensive training or data processing backgrounds. The system shall prompt the operator.

2. Command Input Errors

a. The system shall supervise operator inputs to ensure they are correct for proper execution. Operator input assistance shall be provided whenever a command cannot be executed because of operator input errors.

3. Special Functions

a. The system shall support the following special functions by using a mouse, in addition to all other commands specified:

1) Start/Enable shall manually start equipment and enable monitoring and control of points.
2) Stop/Disable shall manually stop equipment and disable monitoring and control components.
3) Display Diagram shall display diagrams of specific utility systems or interlocks required for operations.
4) Auto/Override shall override automatic operation of a point or return a point to automatic operation.

4. Level of Addressing

a. Four levels of addressing for identification shall be provided as follows:

1) Point. The individual sensor or control device within a unit.
2) Unit. The unit that a point is associated with, such as a pump.
3) Sub-system. The sub-system that a point is located in or near.
4) System. The system that a sub-system is located in or near.

5. System Access Control

a. A minimum of 30 passwords shall be configured into the control system software. The system shall maintain an ASCII disk file logging all operators logged onto the system, alarm acknowledgments, commands issued and all database modifications for each password. Each password shall be definable as to the functions that the operator can perform.

E. INTEGRATOR shall include 2 additional spare screens in base bid. The screens shall be developed during CONSTRUCTION MANAGER meetings and Startup.

2.5 SECURITY

A. Using operator interface and operating system software, implement a security system to restrict access to parts of system. A minimum of 30 passwords shall be configured into the control system software. The system shall maintain an ASCII disk file logging all operators logged onto the system, alarm acknowledgments, commands issued and all database modifications for each password. Each password shall be definable as to the functions that the operator can perform. Provide following as a minimum:

1. Programmer - Access to all facilities including changing displays and logic.

2. Supervisor - Access to all displays, change master set points and purge stale alarm messages.

3. Operator - Access to all displays, change normal operational sequences and acknowledge alarms.

4. Observer - Access to displays only.

2.6 ALARMING

A. Alarm Management: For each process or system event classed as an alarm provide facilities for displaying and logging on system, acknowledgment, and purging of stale messages. Alarm events are derived from discrete inputs, analog trip values, logic combinations and computations as needed. Display both alarm events and returns to normal. Provide date/time stamps for events, descriptive message, and event type code. Use color combinations to distinguish following alarm states: Alarm-Unacknowledged, Alarm-Acknowledged, Normal-Unacknowledged, and Normal-Acknowledged.

B. The software shall notify an operator of the occurrence of an alarm condition. The control system alarm history shall be stored in an ASCII file and shall be recallable by the operator using the report generator. Alarm messages shall take precedence over other functions. A minimum of the most recent 25 system alarms shall be directly available at the operator interface. Operator acknowledgment of one alarm shall not be considered as acknowledgment of any other alarm nor shall it inhibit reporting of subsequent alarms.

Alarm data to be displayed and stored shall include: identification of the alarm; date and time to the nearest second of occurrence; device or sensor type; limit exceeded (if analog); engineering units; current value or status; alarm class; and alarm messages.

C. Digital Alarms

1. Digital alarms shall be subject to immediate reporting, within the alarm response time, at the OIP.

D. Analog Alarms

1. These alarms shall be subject to immediate reporting, within the alarm response time, at the OIP. The control panel analog readings shall be compared to predefined high and low limits, and alarmed to the OIP each time a value enters or returns from a limit condition. The program shall automatically change the high or low limits, or both, of any analog point, based on time scheduled operations as specified, allowing for a time interval before the new alarm limit becomes effective. For those applications where setpoint adjustments are made, the alarm limit shall be keyed to a finite deviation traveling with the setpoint.

E. Alarm Messages

1. Assignment of messages to a point shall be an operator editable function. Secondary messages shall be assignable by the operator for display to provide further information, such as telephone lists or maintenance functions, and shall be editable by the operator.

F. Alarm Classes

1. Classes of alarms, which will be identified for each item, include class 1 and class 2 alarm conditions. Class 1 (Critical) shall include display and audible alarm at occurrence and at return-to-normal. Acknowledgment of class 1 alarms by the operator shall be required at occurrence and at return-to-normal. Class 2 (Informational) shall include display and audible alarm at occurrence and at return-to-normal. No acknowledgment of class 2 alarms is required unless otherwise shown.

G. Critical process alarms shall be derived from an actual field device connected to respective local process control panel or controller and not from the HMI programming software by calculation or other means. This should, however, not be interpreted to mean that that the HMI shall be excluded from performing supervisory alarm handling functions.

H. The system integrator shall work to eliminate all nuisance equipment and process alarms during system commissioning, to the satisfaction of ENGINEER and OWNER. At the completion of the work, the system INTEGRATOR shall provide the CONSTRUCTION MANAGER certification that all instruments and control systems have been

commissioned and are operating in accordance with the contract drawings and specification.

2.7 REPORTING

A. HMI SCADA software shall be provided to generate and format standard and custom reports for displaying and storing on disk. Reports shall use database values and parameters, values calculated using the real time static database or historical data base; with the reports subsequently stored on hard disk or CD drive. Dynamic operation of the system shall not be interrupted to generate a report. The report shall contain the time and date when the sample was taken, and the time and date when the report was printed.

B. Develop reports and data entry facilities to support management and regulatory reporting requirements of facility.

1. Daily motor run times.
2. Daily operations.
3. Laboratory operations.
4. State monthly operations report.
5. U.S. EPA NPDES Report.

C. Provide following data management functions:

1. Collection files are closed at 00:05 of first day of each calendar month and a new file started. Establish a file naming convention based on file type (analog, historical, or motor), month, and year. Provide operator screens for managing file space:

a. Backing up to archive medium.
b. Restoration from archive.
c. Deleting archive files.
d. Display/print of archive catalog.
e. Forcing early closure of collection file.
f. Create export file.

2. Analog Points: Scan each analog point as listed below. Every hour, store minimum, maximum, and average values in a journal file. Do not store values that are out of range, out of service, or not valid for any other reason.

Device Type	Timed Every	Triggered On Update	Triggered Absolute	Triggered Percent
Analytical	15 Min	Yes	-	3
Flow	15 Min	Yes	-	5
Level	30 min	Yes	-	3
Pressure	30 Min	Yes	-	5
Setpoint	1 day	Yes	-	-
Speed	30 Min	Yes	-	3
Temperature	30 Min	Yes	-	3
Total	30 min	Yes	-	5
Valve	30 min	Yes	-	3

1) The point will be logged every time period and whenever the valve changes by triggered amount.
2) Triggered amount is percent of present valve (if absolute and percent are blank then whenever value changes).

3. Historical Trend Data Collection: Establish data collection tables for up to 20 groups of up to 6 process points each with a collection interval of 1 minute. Provide facilities for defining and changing trend groups. Removal and archiving of closed trend files shall be accomplished using operating system's standard backup/restore programs. Do not store values that are out of range, out of service, or not valid for any other reason.

4. Motor Run Times: For each monitored motor, store daily values for running time. Run times may be developed either by scanning points every minute or by providing PLC timer logic. Daily accumulated run times are to be stored at 00:01 of each day and then reset. Close running time data collection file at 00:05 on first day of each month.

5. Data Export: Provide collected data file export facilities for use by management reporting programs and third-party data analysis programs and spreadsheets. Export files shall be ASCII encoded, fixed record (and field) length with carriage control. Export files shall be made from closed collection files on user demand.

D. The Reports shall be developed, with data being stored locally on the server. The reports are listed below;

1. Weekly Process Status Report

   a. Individual Pump Run Times (by day)
   b. Flow Totals (by day)
   c. Individual High, Low, and Average Temperature (by day)
   d. Individual High, Low, and Average Level (by day)
   e. Number of equipment alarms (by day)

2. Weekly Facility Status Report

    a. Individual Unit Run Times (by day)
    b. Flow Totals (by day)
    c. Individual High, Low, and Average Temperature (by day)
    d. Individual High, Low, and Average Power Levels (by day)
    e. Individual High, Low, and Average Voltage, Current, and Power Factors (by day)
    f. Number of equipment alarms (by day)

3. Monthly Report

    a. Individual Pump Run Times (by week)
    b. Individual Flow Totals (by week)

4. Shift Report

    a. Major System status (in-alarm, inservice, out-of-service, remote-manual, remote-auto, local, over-ride, or Maintenance Mode)

5. Spare Report, to be designed during INTEGRATOR workshop with CONSTRUCTION MANAGER (with 20 different points)

PART 3 - EXECUTION

3.1 SOURCE QUALITY CONTROL

A. Conduct preliminary testing prior to factory checkout by executing program for this Project. Use simulated/emulated input and output devices as necessary to verify correct interpretation. Exercise inputs to test logic for correct function and proper response of outputs. Verify correct interface of PLC logic with programs used for Operator Interface and Data Collection Activities.

3.2 SYSTEM REQUIREMENTS

A. Performance Requirements: Programmable logic controllers (PLCs) shall complete execution of all rungs with a cycle time not to exceed 250 ms. Operator interface functions shall have a 2-second response time or better. Adjust timing and operating system parameters of PLCs and computers as necessary.

B. Final Control Element Response: Proper stroke response in magnitude (± 5%) and direction will constitute correct operation.

C. Analog Control Loops: The requirement includes all loop elements (signal conditioners, etc.) up to and including the local operator and remote operator computer interfaces. Each transmitter and signal transducer shall have an accuracy of + or – 0.5 percent (of reading). Signal simulation will be an acceptable substitute for primary element excitations.

3.3 FACTORY TEST

A. INTEGRATOR shall notify Engineer and Owner in writing at least 14 days before the proposed testing date and in no case shall notice be given until after the CONTRACTOR has received written CONSTRUCTION MANAGER approval of the test procedures. If the factory acceptance test is concluded unsuccessfully, the test shall be repeated. INTEGRATOR shall reimburse Owner and Engineer for all expenses incurred in connection with attending repeated factory or site testing necessitated by system failure or inadequate preparation.

B. INTEGRATOR shall prepare a testing procedure to be approved by Owner and Engineer that shall demonstrate that the system conforms to the specifications. The testing procedure shall be submitted at least 30 days in advance of testing. The testing shall be conducted by INTEGRATOR and witnessed by CONSTRUCTION MANAGER.

C. FACTORY TEST SETUP. Assemble and integrate the factory test setup as specified to prove that performance of the system satisfies all requirements of this project, including system communications requirements in accordance with the approved test procedures. The factory test shall take place during regular daytime working hours on weekdays. Equipment used shall be the same equipment that is to be delivered to the site. The factory test setup shall include the following:

	Factory Test
Control Panel	MCPs and RCPs (Remote IO), with all equipment inside
PLC	Controls, and Switchgear
Network Switch	one of each type
Data Storage	one of each type
Operator Interface	one of each type
Portable Tester	one of each type
Communications Circuits and Related Equipment	All equipment including bridges, cellular modems, encoder/decoders, transceivers and repeaters.
I/O Functions	sufficient to demonstrate the I/O capability and system normal operation
Software	software required for proper operation of the proposed system including application programs and sequences of operation

FACTORY TEST PROCEDURE. Test procedures shall define the tests required to ensure that the system meets technical, operational, and performance requirements. The test procedures shall define location of tests, milestones for the tests, and identify simulation programs, equipment, personnel, facilities, and supplies required. The test procedures shall provide for testing all control system capabilities and functions specified and shown. The procedures shall cover actual equipment and sequences to be used by the Contractor for the specified project and shall consist of detailed instructions for test setup, execution, and evaluation of test results. The test reports shall document results of the tests. Reports shall be delivered to the

CONSTRUCTION MANAGER within 7 days after completion of each test. The procedures shall include the following:

	Test Procedure
Equipment	Block Diagram
Hardware and Software	Descriptions
commands	Operator Commands
I/O Functions	Test Database Points with Failure Modes
Passwords	Required for Each Operator Access Level
Each Type of Digital and Analog Point in the Test Database	Description
Test Equipment	List
Surge Protection	Circuit Diagrams
Inputs Required (I/O Point Values and Status) and Corresponding Expected Results of Each Set of Input Values	For Each Application Program
Default Values	For the Application Program Inputs Not Implemented or Provided for in the Contract Documents for the Application Programs to be Tested.
Verification Shall Include at a Minimum	• Pump call for each pump • Pump run indication for each pump • Run time for each pump • Programmable fault inputs and outputs • Pump in local or remote control • Manual control of the pump speed in percent • Failed to run alarm – user configurable time • Failed to stop alarm– user configurable time • Valve open/pump stopped alarm– user configurable time • Valve closed/pump running alarm– user configurable time • Valve Position Mismatch alarm – speed called for and actual speed to far apart • Valve open/closed indication • Runtime counter • Number of Starts counter • Output relay for each pump – is the pump being called to start • Utility Power Fail Alarm

D. FACTORY ACCEPTANCE TESTING. After system assembly and debugging at EQUIPMENT SUPPPLIER's facility, the system shall be tested before the system is shipped to the site. The factory test shall be conducted on at the system consisting of computer hardware, software, printer, and one field I/O device.

1. The entire system, including all peripherals and associated software, shall be factory tested under simulated operating conditions. Both normal operating sequences and fault conditions shall be simulated. The results shall be noted on the displays and the logging printer for hard copy. The testing procedures for hardware and software are described below. All basic functions shall be demonstrated, including I/O processing, communications, alarm handling, HMI and OIP display functions, alarm logging, report generation, and historical data storage, as well as the specific functions listed herein. The system shall operate continuously for at least a 72 hours without faults. This operational test may run concurrently with the demonstration of hardware and software functions. The test procedure shall also include at a least four-hour period for discretionary tests to be conducted by CONSTRUCTION MANAGER. For systems with software configuration by CONSTRUCTION MANAGER, a preliminary version of such configured software may be used as part of the factory acceptance test.

2. Software Test. All system software modules specified herein shall be demonstrated. Software tests shall include running all diagnostics, debugging routines, and system test routines. The operating system, advanced process control language compiler, and all associated drivers shall be fully tested and operable for the system test. Software "patches" or changes to bypass failed or flawed modules during the test will not be acceptable.

E. FACTORY TEST REPORT. Original copies of data produced during the factory test, including results of each demonstration procedure, shall be delivered to the CONSTRUCTION MANAGER at the conclusion of the test, prior to CONSTRUCTION MANAGER approval of the factory test. The report shall be arranged so that commands, responses, and data acquired are correlated to allow logical interpretation of the data.

F. EQUIPMENT SUPPLIER is responsible for supplying computer and software for Factory Acceptance Test. EQUIPMENT SUPPLIER shall attempt to match existing treatment facility computer and loaded software.

3.4 SOFTWARE INSTALLATION

A. Load software required for an operational control system, including databases (for points specified and shown), operational parameters, and system, command, and application programs. Adjust, tune, debug, and commission all software and parameters for controlled systems to assure proper operation in accordance with the sequences of operation and database tables.

B. SYSTEM SOFTWARE CONFIGURATION. System software shall be configured by the INTEGRATOR. Configuration services shall consist of system database, report formats, operator interface graphic and tabular display screen formats, password and security implementation, and programming of control units to provide a fully functioning system. The INTEGRATOR shall fully configure the system using data provided herein or supplied by the Engineer and/or the Owner after award of the contract.

1. Tuning of software programs shall be accomplished in such a manner that the program operates at its highest performance level. These programs include, but are not limited to Microsoft Office, all PLC ladder logic, and others.

2. Software used for programming the PLCs shall be provided by the INTEGRATOR for his own use. PLC programming software used under this contract shall create electronic files compatible with the existing treatment facilities current version of Siemens Step 7. Two copies of the PLC programming software will be turned over to the CONSTRUCTION MANAGER. Under no condition shall the INTEGRATOR provide any part of the software code locked out to the CONSTRUCTION MANAGER. ALL CODE SHALL BE MODIFIABLE.

3. INTEGRATOR shall verify network condition during construction, and after construction.

3.5 FIELD TESTING AND ADJUSTING EQUIPMENT

A. Provide personnel, equipment, instrumentation, and supplies necessary to perform site testing. The CONSTRUCTION MANAGER will witness the SAT, and written permission shall be obtained from the OWNER before proceeding with the testing. Original copies of data produced, including results of each test procedure, during SAT shall be turned over to the ENGINEER at the conclusion of each phase of testing prior to CONSTRUCTION MANAGER approval of the test. The test procedures shall cover actual equipment and functions specified for the project.

B. Testing, Adjusting and Commissioning

1. After successful completion of the factory test as specified, the Contractor will be authorized to proceed with the installation of the system equipment, hardware, and software. Once the installation has been completed, test, adjust, and commission each control loop and system in accordance with NIST SP 250 and shall verify proper operation of each item in the sequences of operation, including hardware and software. Calibrate field equipment, including control devices, adjust control parameters and logic (virtual) points including control loop setpoints, gain constants, constraints, and verify data communications before the system is placed online. Calibrate each instrumentation device connected to the control system control network by making a comparison between the reading at the device and the display at the workstation, using a standard at least twice as accurate as the device to be calibrated. Check each control point within the control system control network by making a comparison between the control command at the central station and field-controlled device. Deliver trend logs/graphs of all points showing to the CONSTRUCTION MANAGER that stable control has been achieved. Points on common systems shall be trended simultaneously. One log shall be provided showing concurrent samples taken once a minute for a total of 4 hours. One log shall be provided showing concurrent samples taken once every 30 minutes, for a total of 24 hours. Verify operation of systems in the specified failure modes upon Control system network failure or loss of power, and verify that

systems return to control system control automatically upon a resumption of control system network operation or return of power. Deliver a report describing results of functional tests, diagnostics, calibrations and commissioning procedures including written certification to the CONSTRUCTION MANAGER that the installed complete system has been calibrated, tested, adjusted and commissioned and is ready to begin the SAT. The report shall also include a copy of the approved SAT procedure.

3.6 SITE ACCEPTANCE TEST

A. Provide personnel, equipment, instrumentation, and supplies necessary to perform site testing. The CONSTRUCTION MANAGER will witness the Site Acceptance Test (SAT), and written permission shall be obtained from the CONSTRUCTION MANAGER before proceeding with the testing. Original copies of data produced, including results of each test procedure, during SAT shall be turned over to the CONSTRUCTION MANAGER at the conclusion of each phase of testing prior to CONSTRUCTION MANAGER approval of the test. The test procedures shall cover actual equipment and functions specified for the project.

B. INTEGRATOR shall prepare a testing procedure to be approved by Owner and Engineer that shall demonstrate that the system conforms to the specifications. The testing procedure shall be submitted at least 30 days in advance of testing. The testing shall be conducted by INTEGRATOR and witnessed by CONSTRUCTION MANAGER. The test procedure shall describe all tests to be performed and other pertinent information such as specialized test equipment required and the length of the SAT. The test procedures shall explain, in detail, step-by-step actions and the expected results, to demonstrate compliance with all the requirements of the drawings and this specification. The test procedure shall be site specific and based on the inputs and outputs, required calculated points and the sequence of control. Demonstrate that the completed Control system complies with the contract requirements. All physical and functional requirements of the project including communication requirements shall be demonstrated and shown. Demonstrate that each system operates as required in the sequence of operation. The SAT as specified shall not be started until after receipt by the Contractor of written permission by the CONSTRUCTION MANAGER, based on the Contractor's written report including certification of successful completion of testing, adjusting and commissioning as specified, and upon successful completion of training as specified. Verify alarms meet EEMUA 191 occurrence thresholds. Upon successful completion of the SAT, deliver test reports and other documentation as specified to the CONSTRUCTION MANAGER.

3.7 ENDURANCE TEST

A. Use the endurance test to demonstrate the overall system reliability of the completed system. The endurance test shall be conducted in phases. The endurance test shall not be started until the CONSTRUCTION MANAGER notifies the Contractor in writing that the SAT is satisfactorily completed, training as specified has been completed, outstanding deficiencies have been satisfactorily corrected, and that the Contractor has permission to

start the endurance test. Provide an operator to man the system 8 hours per day during daytime operations, including weekends and holidays, during Phase I endurance testing, in addition to any OWNERS personnel that may be made available. The CONSTRUCTION MANAGER may terminate testing at any time when the system fails to perform as specified. Upon termination of testing by the CONSTRUCTION MANAGER or by the Contractor, commence an assessment period as described for Phase II. Upon successful completion of the endurance test, deliver test reports and other documentation, as specified, to the CONSTRUCTION MANAGER prior to acceptance of the system.

B. Phase I (Testing)

1. The test shall be conducted 24 hours per day, 7 days per week, for 10 consecutive calendar days, including holidays, and the system shall operate as specified. Make no repairs during this phase of testing unless authorized by the CONSTRUCTION MANAGER in writing.

C. Phase II (Assessment)

1. After the conclusion of Phase I, identify failures, determine causes of failures, repair failures, and deliver a written report to the CONSTRUCTION MANAGER. The report shall explain in detail the nature of each failure, corrective action taken, results of tests performed, and shall recommend the point at which testing should be resumed. After delivering the written report, convene a test review meeting at the job site to present the results and recommendations to the CONSTRUCTION MANAGER. The meeting shall not be scheduled earlier than 5 business days after receipt of the report by the CONSTRUCTION MANAGER. As a part of this test review meeting, demonstrate that failures have been corrected by performing appropriate portions of the site acceptance test. The CONSTRUCTION MANAGER reserves the right to cancel the test review meeting if no failures or deficiencies occur during the Phase I testing. If the CONSTRUCTION MANAGER chooses to do so, the Contractor will be notified in writing. Based on the Contractor's report and the test review meeting, the CONSTRUCTION MANAGER will determine if retesting is necessary and the restart point. The CONSTRUCTION MANAGER reserves the right to require that the Phase I test be totally or partially rerun. Do not commence any required retesting until after receipt of written notification by the CONSTRUCTION MANAGER. After the conclusion of any retesting which the CONSTRUCTION MANAGER may require, the Phase II assessment shall be repeated as if Phase I had just been completed.

D. Exclusions

1. The Contractor will not be held responsible for failures resulting from the following: Outage of the main power supply in excess of the capability of any backup power source, provided that the automatic initiation of all backup sources was accomplished and that automatic shutdown and restart of the control system performed as specified. Failure of a CONSTRUCTION MANAGER furnished

communications link, provided that the PLC automatically and correctly operates in the stand-alone mode as specified, and that the failure was not due to Contractor furnished equipment, installation, or software. Failure of existing equipment, provided that the failure was not due to Contractor furnished equipment, installation, or software.

3.8 OPERATOR TRAINING

A. Field training oriented to the specific system shall be provided for designated personnel. A copy of the training manual for each trainee plus two additional copies shall be delivered to the CONSTRUCTION MANAGER. Manuals shall include an agenda, the defined objectives for each lesson, and a detailed description of the subject matter for each lesson. Furnish audiovisual equipment and other training supplies and materials. Copies of the audiovisuals shall be delivered with the printed training manuals. The CONSTRUCTION MANAGER reserves the right to videotape training sessions for later use. A training day is defined as 8 hours of classroom instruction, excluding lunchtime, Monday through Friday, during the daytime shift in effect at the training facility. Approval of the Contractor's training schedule shall be obtained from the CONSTRUCTION MANAGER at least 30 days before the training.

B. Preliminary Operator Training; Immediately following the first pump startup and signoff, preliminary operator training shall be taught at the project site for three consecutive training days. Upon completion of this course, each student, using appropriate documentation, should be able to perform elementary operations with guidance and describe the general hardware architecture and functionality of the system. This course shall include: day-to- day monitoring and/or control of the facilities; general system architecture; functional operation of the system, including workstations; operator commands; application programs, control sequences, and control loops; database entry and modification; reports generation; alarm reporting; diagnostics; and historical files. The training program shall provide operators with sufficient knowledge to move from screen to screen within the system, understand the contents of group and detailed point displays, react to and acknowledge alarms, adjust control setpoints and alarm limits, configure and print shift reports, print preconfigured reports on demand, control equipment connected to the system, and react to and resolve minor system errors.

C. Additional Operator Training; Following the final pump startup and signoff, additional classroom training for operators shall be taught for three separate, but identical, sessions for three shifts of personnel and shall be conducted at Owner’s facilities. Each class shall consist of 8 hours of instruction using the lesson plan submitted and approved for use. The post- installation sessions may have to be conducted outside normal working hours to accommodate the working schedule of Owner’s personnel. The post-installation training sessions shall be conducted for 8 of the Owner’s operating personnel. Individual instruction shall consist of "hands-on" training under the constant monitoring of the instructor. Classroom training shall include instruction on the specific software configuration of the installed control system and specific instructions for operating the installed system. Schedule activities during this period so that the specified amount of time on the equipment will be available for each student. The final session will address

specific topics that the students need to discuss and to answer questions concerning the operation of the system. Upon completion of the course, the students should be fully proficient in system operation and have no unanswered questions regarding operation of the installed control system. Each student should be able to start the system, operate the system, recover the system after a failure and describe the specific hardware architecture and operation of the system and be fully proficient in all system operations. Report the skill level of each student at the end of this course. Operator Training shall include, at a minimum, the following topics.

1. Power-up, "bootstrapping", and shutdown of all hardware devices.
2. Logging on and off the system and the use of passwords.
3. Access and interpretation of standard displays and diagnostics.
4. Use and care of operator workstations, servers, video displays, printers, and other control room hardware, including replenishment of supplies and replacement of ribbons and ink cartridges.
5. Response to and acknowledgment of alarms.
6. Adjustment of control set points and alarm limits.
7. Control of field equipment and devices connected to the system.
8. Appropriate responses to software and hardware errors.
9. Enabling and disabling individual inputs and outputs.

D. Operator Training program shall be developed for personnel with no prior computer experience.

E. Maintenance Training (Specifically Focuses on Hardware)

1. Following the endurance test, a minimum period of five training days shall be provided by a factory representative or a qualified Contractor trainer for ten designated personnel on maintenance of the equipment. The training shall include: physical layout of each piece of hardware, calibration procedures, preventive maintenance procedures, schedules, troubleshooting, diagnostic procedures and repair instructions.

2. The vendor shall offer complete and comprehensive training programs for the system, including the controller, networks, and OS.

3. The controller hardware training course content shall include, but not be limited to:

    a. CPU, power supply, communication cards, backplane, local and remote I/O racks.
    b. I/O cards
    c. Communications and Ethernet communication
    d. Fault tolerant architecture and failsafe architecture.

4. The Operating System hardware training course content shall include, but not be limited to:

a. System Overview
b. Client and server architecture, including networking and redundancy
c. The display hierarchy, and the graphical, trending, alarm, reporting, and batch displays

F. Engineering Training (Specifically focuses on software)

1. The engineering training course content shall include, but not be limited to tools for:

a. Configuration of the I/O hardware devices
b. Configuration of the communication networks
c. Configuration of continuous and sequential control operations
d. Design of operating and monitoring strategies

2. Operating system engineering training course content shall include, but not be limited to tools for:

a. Creation of an OS system application
b. Creation, administration and management of OS system database
c. Creation, administration, and management of graphics displays
d. Creation, administration, and management of system alarming
e. Creation, administration, and management of the historical subsystem
f. Creation, administration, and management of the reporting subsystem
g. HMI Scripting

END OF SECTION

SPECIFICATION REVISION INDEX

Revision No.	Revision Date	Issued for	Signatures				
			Prepared By	Reviewed By	Project Engineer	Project Manager	Client
A	11/28/2016	60% Submittal	CMF	JG	JG	STD	
B	2/15/2017	75% Submittal	CMF	JG	JG	STD	

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SECTION 15000

MECHANICAL-GENERAL REQUIREMENTS

PART 1 GENERAL

1.01 DESCRIPTION:

A. Scope of Work:

1. All equipment furnished and installed under this contract shall conform to the general stipulations set forth in this section except as otherwise specified in other sections.

2. General Contractor shall coordinate all details of equipment with other related parts of the Work, including verification that all structures, piping, wiring, and equipment components are compatible. General Contractor shall be responsible for all structural and other alternations in the Work required to accommodate equipment differing in dimensions or other characteristics from that contemplated in the Contract Drawings or Specifications.

B. Related Work Described Elsewhere:

1. General Requirements: Division 1

2. Concrete: Division 3

3. Metals: Division 5

4. Finishes: Division 9

5. Equipment: Division 11

6. Special Construction: Division 13

7. Electrical: Division 16

C. General Design:

1. Contract Drawings and Specifications: The Contract Drawings and Specifications shall be considered as complementary, one to the other, so that materials and work indicated, called for, or implied by the one and not by the other shall be supplied and installed as though specifically called for by both. The Contract Drawings are to be considered diagrammatic, not necessarily showing in detail or to scale all of the equipment or minor items. In the event of discrepancies between the Contract Drawings and Specifications, or between either of these and any regulations or ordinances governing work of these specifications, the bidder shall notify the Engineer in ample time to permit revisions.

1.02 QUALITY ASSURANCE:

A. Materials and Equipment: Unless otherwise specified, all materials and equipment furnished for permanent installation in the work shall conform to applicable standards and specifications and shall be new, unused, and undamaged when installed or otherwise incorporated in the work. No such material or equipment shall be used by the General Contractor for any purpose other than that intended or specified, unless such use is specifically authorized in writing by the Engineer. No material shall be delivered to the work site workout prior acceptance of drawings and data by the Engineer.

B. Equivalent Materials and Equipment:

1. Whenever a material or article is specified or described by using the name of a proprietary product or the name of a particular manufacturer or vendor, the specific item mentioned shall be understood as establishing the type, function, and quality desired. Other manufacturers' products will be accepted provided sufficient information is submitted to allow the Engineer to determine that the products proposed are equivalent to those named. Such items shall be submitted for review in accordance with Section 01330 – Shop Drawings.

2. Requests for review of equivalency will not be accepted from anyone except the General Contractor and such requests will not be considered until after the contract has been awarded.

C. Governing Standards: Equipment and appurtenances shall be designed in conformity with ANSI, ASME, ASTM, IEEE, NEMA, OSHA, AGMA, and other generally accepted applicable standards. They shall be of rugged construction and of sufficient strength to withstand all stresses which may occur during fabrication, testing, transportation, installation, and all conditions or operations. All bearings and moving parts shall be adequately protected against wear by bushings or other acceptable means. Provisions shall be made for adequate lubrication with readily accessible means.

D. Tolerances: Machinery parts shall conform to the dimensions indicated on the drawings within allowable tolerances. Protruding members such as joints, corners, and gear covers shall be finished in appearance. All exposed welds shall be ground smooth and the corners of structural shapes shall be rounded or chamfered.

E. Clearances: Ample clearances shall be provided for inspection and adjustment. All equipment shall fit the allotted space and shall leave reasonable access room for servicing and repairs. Greater space and room required by substituted equipment shall be provided by the General Contractor and at his expense.

F. Testing:

1. When the equipment is specified to be factory tested, the results of the tests shall be submitted to the Engineer and approval of the test results shall be obtained before shipment of the equipment.

2. When an item of equipment, including controls and instrumentation, has been completely erected, the General Contractor shall notify the Engineer, who will designate a time to make such tests as required, and operate the item to the satisfaction of the General Contractor. All testing shall be done in the presence of the General Contractor. "Completely erected" shall mean that the installation is erected, all necessary adjustments have been made, all required utility connections have been made, required lubricants and hydraulic fluid have been added and the unit has been cleaned and painted.

G. Pressure Test:

1. After installation, all piping shall be pressure tested. Piping shall be tested in accordance with Section 15044– Pressure Testing of Piping for plant piping, 15140 – Water Distribution Piping, or Section 15211 – General Service Compressed Air Piping.

2. All tests shall be made in the presence of and to the satisfaction of the Engineer and also, to the satisfaction of any local or state inspector having jurisdiction.

   a. Provide not less than three days notice to the Engineer and the authority having jurisdiction when it is proposed to make the tests.

   b. Any piping or equipment that has been left unprotected and subject to mechanical or other injury in the opinion of the Engineer shall be retested in part or in whole as directed by the Engineer.

   c. The piping systems may be tested in sections as the work progresses by no joint or portion of the system shall be left untested.

3. All elements within the system that may be damaged by the testing operation shall be removed or otherwise protected during the operation.

4. All defects and leaks observed during the tests shall be corrected and made tight in an approved manner and the tests repeated until the system is proven tight.

5. Repair all damage done to existing or adjacent work or materials due to or on account of the tests.

6. Provide test pumps, gauges, or other instruments and equipment required for the performance of all tests. Provide all temporary bracing, test plugs, additional restraint, and thrust blocking which may be required for test pressures above normal working pressures.

7. All tests shall be maintained for as long a time as required to detect all defects and leaks but not less than the duration specified for each type of pipe or piping system in this Division.

H. Failure of Test:

1. Defects: Any defects in the equipment, or deviations from the guarantees or requirements of the Specifications, shall be promptly corrected by the General Contractor by replacements or otherwise. The decision of the Engineer as to whether or not the General Contractor has fulfilled his obligations under the Contract shall be final and conclusive. If the General Contractor fails to correct any defects or deviations, or if the replaced equipment when tested shall fail again to meet the guarantees or specified requirements, the Engineer, notwithstanding his having made partial payment for work and materials which have entered into the manufacturer for such equipment, may reject that equipment and order the General Contractor to remove it from the premises at the General Contractor'S expense.

2. Rejection of Equipment: In case the Engineer rejects a particular item of equipment, then the General Contractor hereby agrees to repay to the Engineer all sums of money paid to him to deliver to the General Contractor a bill of sale of all his rights, title, and interest in and to the rejected equipment provided, however that the equipment shall not be removed from the premises until the Engineer obtains from other sources other equipment to take the place of that rejected. The bill of sale shall not abrogate the Engineer's right to recover damages for delays, losses or other conditions arising out of the basic Contract. The Engineer hereby agrees to obtain the alternate equipment within a reasonable time and the General Contractor agrees that the Engineer may use the original equipment furnished by him without rental or other charge until the other equipment is obtained.

I. Responsibility During Tests: The General Contractor shall be fully responsible for the proper operation of equipment during tests and instruction periods and shall neither have nor make any claim for damage which may occur to equipment prior to the time when the Engineer formally takes over the operation thereof.

J. Acceptance of Materials:

1. Only new materials and equipment shall be incorporated in the work. All materials and equipment furnished by the General Contractor shall be subject to the inspection and acceptance of the Engineer. No material shall be delivered to the work without prior submittal approval of the Engineer.

2. The General Contractor shall submit to the Project Manager and Professional Engineer data relating to materials and equipment he proposes to furnish for the work. Such data shall be in sufficient detail to enable the Engineer to identify the particular product and to form an opinion as to its conformity to the specifications.

3. Facilities and labor for handling and inspection of all materials and equipment shall be furnished by the General Contractor. If the Engineer requires, either prior to beginning or during the progress of the work, the General Contractor shall submit samples of materials for such special test as may be and pay for tests.

4. The MECHANICAL necessary to demonstrate that they conform to the specification. Such sample shall be furnished, stored, packed, and shipped as directed at the General Contractor'S expense. Except as otherwise noted, the Engineer will make arrangements for General Contractor shall submit data and samples sufficiently early to permit consideration and acceptance before materials are necessary for incorporation in the work.

K. Safety Requirements:

1. In addition to the components shown and specified, all machinery and equipment shall be safeguarded in accordance with the safety features required by the current codes and regulations of ANSI, OSHA, and local industrial codes.

2. The General Contractor shall provide for each V-belt drive or rotating shaft a protective guard which shall be securely bolted to the floor or apparatus. The guard shall completely enclose drives and pulleys and be constructed to comply with all safety requirements.

3. For double inlet fans, the belt guard shall be arranged so as not to restrict the air flow into the fan inlet. Guards shall not interfere with lubrication of equipment.

1.03 SUBMITTALS (SEE SECTION 01330: SHOP DRAWINGS)

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING:

1. Packaging: All equipment shall be suitably packaged to facilitate handling and protect against damage during transit and storage. All equipment shall be boxed, crated, or otherwise completely enclosed and protected during shipment, handling, and storage. All equipment shall be protected from exposure to the elements and shall be kept thoroughly dry at all times.

B. Protection: All machined surfaces and shafting shall be cleaned and protected from corrosion by the proper type and amount of coating necessary to assure protection during shipment and prior to installation. Painted surfaces shall be protected against impact, abrasion, discoloration, and other damage as specified in Sections 09900 – Painting. All painted surfaces which are damaged prior to acceptance of equipment shall be repainted to the satisfaction of Engineer.

C. Lubrication: Grease and lubricating oil shall be applied to all bearings and similar items as necessary to prevent damage during shipment and storage.

D. Marking: Each item of equipment shall be tagged or marked as identified in the delivery schedule or on the Shop Drawings. Complete packing lists and bills of material shall be included with each shipment.

E. Fabricated sub-assemblies, if any, shall be shipped in convenient sections as permitted by carrier regulations and shall be properly match-marked for ease of field erection.

F. Responsibility:

1. The General Contractor shall be responsible for all material, equipment, and supplies sold and delivered to the site under this Contract until final inspection of the work and acceptance thereof by the Engineer. In the event any such material, equipment, and supplies are lost, stolen, damaged, or destroyed prior to final inspection and acceptance, the General Contractor shall replace same without additional cost to the Engineer.

1. Should the General Contractor fail to take proper action on storage and handling of equipment supplied under this Contract within seven days after written notice to do so has been given, the Engineer retains the right to correct all deficiencies noted in previously transmitted written notice and deduct the cost associated with these corrections from the General Contractor'S Contract. These costs may be comprised of expenditures for labor, equipment usage, administrative, clerical, engineering, and any other costs associated with making the necessary corrections.

G. Delivery: The General Contractor shall arrange deliveries of products in accordance with construction schedules and coordinate to avoid conflict with work and condition at the site.

1. The General Contractor shall deliver products in undamaged condition, in manufacturer's original containers or packaging, with identifying labels intact and legible.

1. Immediately on delivery, the General Contractor shall inspect shipments to assure compliance with requirements of Contract Documents and accepted submittals, and that products are properly protected and undamaged.

1. Under no circumstances shall the General Contractor deliver equipment to the site more than one month prior to installation without written authorization from the Engineer. Operation and maintenance data shall be submitted to the Engineer for review prior to shipment of equipment as described in Section 01730 – Operations and Maintenance Manuals.

H. Storage and Protection of Products:

1. The General Contractor shall furnish a covered, weather-protected storage structure providing a clean, dry noncorrosive environment for all mechanical equipment, valves, architectural items, electrical and instrumentation equipment, and special equipment to be incorporated into this project. Storage of equipment shall be in strict accordance with the "Instructions for Storage" of each equipment supplier and manufacturer including connection of space heaters, and placing of storage lubricants in equipment. Corroded, damaged, or deteriorated equipment and parts shall be replaced before acceptance of the project. Equipment and materials not properly stored will not be included in a payment estimate.

1. The General Contractor shall store products subject to damage by the elements in weathertight enclosures.

b. The General Contractor shall maintain temperature and humidity within the ranges required by manufacturer's instructions.

c. The General Contractor shall store fabricated products above the ground, on blocking or skids, to prevent soiling or staining. The General Contractor shall cover products which are subject to deterioration with impervious sheet coverings and provide adequate ventilation to avoid condensation.

d. The General Contractor shall store loose granular materials in a well drained area on solid surfaces to prevent mixing with foreign matter.

1. All materials and equipment to be incorporated in the work shall be handled and stored by the General Contractor before, during, and after shipment in a manner to prevent warping, twisting, bending, breaking, chipping, rusting, and any injury, theft, or damage of any kind whatsoever to the material or equipment.

4. All materials which, in the opinion of the Engineer, have become damaged and are unfit for the use intended or specified, shall be promptly removed from the site of the work, and the General Contractor shall receive no compensation for the damaged material or its removal.

5. The General Contractor shall arrange storage in a manner to provide easy access for inspection. The General Contractor shall make periodic inspections of stored products to assure products are maintained under specified conditions, and free from damage or deterioration.

6. Protection After Installation: The General Contractor shall provide substantial coverings as necessary to protect installed products from damage from traffic and subsequent construction operations. The General Contractor shall remove covering when no longer needed.

1. Extended Storage Requirements For Equipment: Because of the long period allowed for construction, special attention shall be given to extended storage and handling of equipment onsite. As a minimum, the procedure specified herein shall be followed:

1. If equipment will be stored onsite for more than one month prior to incorporation into the Work, the General Contractor shall submit a written request to the Engineer outlining any special provision to be made to protect and maintain the equipment while it is being stored. All such provisions shall be acceptable to the Engineer. No equipment shall be stored onsite for more than one month without prior written authorization from the Engineer.

1. All equipment having moving parts including gears, electric motors, and/or instruments shall be stored in a temperature and humidity controlled building accepted by the Engineer, until such time as the equipment is to be installed.

1. All equipment shall be stored fully lubricated with oil and grease unless otherwise instructed by the manufacturer.

4. Manufacturer’s storage instructions shall be carefully studied by the General Contractor and reviewed by him with the Manufacturer’s Representative. These instructions shall be carefully followed and a written record of this review kept by the General Contractor.

5. Moving parts shall be rotated a minimum of once weekly to ensure proper lubrication and to avoid metal-to-metal “welding”. Upon installation of the equipment, the General Contractor shall start the equipment, and operate loaded when possible, weekly for an adequate period of time to ensure that the equipment does not deteriorate from lack of use.

6. Lubricants shall be changed upon completion of installation and as frequently as required thereafter during the period between installation and acceptance. Mechanical equipment to be used in the work, if stored for longer than ninety days, shall have the bearings cleaned, flushed, and lubricated prior to testing and startup, at no extra cost to the Engineer.

7. Prior to acceptance of the equipment, the General Contractor shall have the manufacturer inspect the equipment and certify that its condition has not been detrimentally affected by the long storage period. Such certifications by the manufacturer shall be deemed to mean that the equipment is judged by the manufacturer to be in a condition equal to that of equipment that has been shipped, installed, tested, and accepted in a minimum time period. As such, the manufacturer will guarantee the equipment equally in both instances. If such a certification is not given, the equipment shall be judged to be defective, and it shall be removed and replaced at the General Contractor’S expense.

8. A maintenance log shall be maintained by the General Contractor outlining the schedule of maintenance required for each piece of equipment as well as the date on which the maintenance was actually performed and the initials of the individual performing the work. Submit a copy of the maintenance log monthly with the progress pay application.

1.05 WARRANTY AND GUARANTEES:

A. The manufacturer's written warranty shall be submitted for all major pieces of equipment, as specified in Section 01600 – Materials and Equipment. The manufacturer's warranty period shall be concurrent with the General Contractor's correction period for one (1) year after the time of completion and acceptance.

PART 2 PRODUCTS

2.01 GENERAL:

A. All materials that come into contact with the water being treated or the finished water shall be on either the EPA or NSF lists of products approved for use in contact with potable water. Manufacturers shall submit an affidavit with the shop drawings indicating approval by the EPA or NSF for the materials used in products that come into contact with the water.

2.02 MATERIALS AND EQUIPMENT:

A. Fabrication and Manufacture:

1. Workmanship and Materials:

a. General Contractor shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage or other failure. Materials shall be suitable for service conditions.

b. All equipment shall be designed, fabricated, and assembled in accordance with recognized and acceptable Engineering and shop practice. Individual parts shall be manufactured to standard sizes and gages so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except as required by tests.

c. Except where otherwise specified, structural and miscellaneous fabricated steel used in equipment shall conform to AISC standards. All structural members shall be designed for shock or vibratory loads. Unless otherwise specified, all steel which will be submerged, all or in part, during normal operation of the equipment shall be at least 1/4 inch thick.

2. Lubrication:

a. Equipment shall be adequately lubricated by systems which require attention no more frequently than weekly during continuous operation. Lubrications systems shall not require attention during startup or shutdown and shall not waste lubricants.

b. Lubricants of the type recommended by the equipment manufacturer shall be furnished by the General Contractor in sufficient quantity to fill all lubricant reservoirs and to replace all consumption during testing, startup, and operation prior to acceptance of equipment by Engineer. Unless otherwise specified or permitted, the use of synthetic lubricants will not be acceptable.

c. Lubrication facilities shall be convenient and accessible. Oil drains and fill openings shall be easily accessible from the normal operating area or platform. Drains shall allow for convenient collection of waste oil in containers from the normal operating area or platform without removing the unit from its normal installed position.

3. Electric Motors: Unless otherwise specified, motors furnished with equipment shall be rated and constructed as specified in Division 16 – Electrical.

a. Manufacturer's standard motor may be supplied on integrally constructed, packaged assemblies such as appliances, tools, unit heaters, and similar equipment specified by model number, in which case a redesign of the unit would be required to furnish motors of other than the manufacturer's standard design. However, in all cases, totally enclosed motors are preferred and shall be furnished if offered by the manufacturer as a standard option.

4. Drive Units: The nominal input horsepower rating of each gear or speed reducer shall be at least equal to the nameplate horsepower of the drive motor. Drive units shall be designed for 24 hour continuous service.

a. Gear Reducers:

i. Each gear reducer shall be a totally enclosed unit with oil or grease lubricated antifriction, rolling element bearings throughout.

ii. Helical, spiral bevel, combination bevel-helical, and worm gear reducers shall have a service factor of at least 1.50 based on the nameplate horsepower of the drive motor. Shaft-mounted and flange-mounted gear reducers shall be rated AGMA Class 11. Helical gear reducers shall have a gear strength rating to catalog rating of 1.5. Each gear reducer shall bear an AGMA nameplate.

iii. The thermal horsepower rating of each unit shall equal or exceed the nameplate horsepower of the drive motor. During continuous operation, the maximum sump oil temperature shall not rise more than 100 F above the ambient air temperature in the vicinity of the unit and shall not exceed 200 F.

iv. Each grease lubricated bearing shall be installed in a bearing housing designed to facilitate periodic regreasing of the bearing by means of a manually operated grease gun. Each bearing housing shall be designed to evenly distribute new grease, to properly dispose of old grease, and to prevent overgreasing of the bearing. The use of permanently sealed, grease lubricated bearings will not be acceptable. An internal or external oil pump and appurtenances shall be provided if required to properly lubricate oil lubricated bearings. A dipstick or sight glass arranged to permit visual inspection of lubricant level shall be provided on each unit.

v. Gear reducers which require the removal of parts or periodic disassembly of the unit for cleaning and manual regreasing of bearings will not be acceptable.

vi. Certification shall be furnished by the gear reducer manufacturer indicating that the intended application of each unit has been reviewed in detail by the manufacturer and that the unit provided

is fully compatible with the conditions of installation and service.

b. Variable Speed Drives: Each variable speed drive shall have a service factor of at least 1.75 at maximum speed based on the nameplate horsepower of the drive motor. A spare belt shall be provided with each variable speed drive unit employing a belt for speed change. Unless specifically permitted by the detailed equipment specifications, bracket type mounting will not be acceptable for variable speed drives.

c. V-Belt Drives: Each V-belt drive shall include a sliding base or other suitable tension adjustment. V-belt drives shall have a service factor of at least 1.6 maximum speed based on the nameplate horsepower of the drive motor.

5. Safety Guards: All belt or chain drives, fan blades, couplings, and other moving or rotating parts shall be covered on all sides by a safety guard. Safety guards shall be fabricated form 16 USS gage or heavier galvanized or aluminum-clad sheet steel or 1/2 inch mesh galvanized expanded metal. Each guard shall be designed for easy installation and removal. All necessary supports and accessories shall be provided for each guard. Supports and accessories, including bolts, shall be galvanized. All safety guards in outdoor locations shall be designed to prevent the entrance of rain and dripping water.

6. Equipment Foundation Supports:

a. All foundations, platforms and hangers required for the proper installation of equipment shall be furnished and installed by the General Contractor.

b. Unless otherwise indicated or specified, all equipment shall be installed on reinforced concrete bases at least 6 inches high and shall conform to Section 03000 –Concrete. Cast iron or welded steel baseplates shall be provided for compressors, and other equipment. Each unit and its drive assembly shall be supported on a single baseplate of neat design. Baseplates shall have pads for anchoring all components and adequate grout holes. Baseplates shall be anchored to the concrete base with suitable stainless steel expansion anchor bolts.

c. The General Contractor shall furnish, install and protect all necessary guides, bearing plates, anchor and attachment bolts, and all other appurtenances required for the installation of equipment. These shall be of ample size and strength for the purpose intended.

d. Equipment suppliers shall furnish suitable anchor bolts for each item of equipment. Anchor bolts, together with templates or setting drawings, shall be delivered sufficiently early to permit setting the anchor bolts when the structural concrete is placed. Anchor bolts shall comply with Division 5 – Metals and, unless otherwise specified, shall have a minimum diameter of 3/4 inch. Unless otherwise indicated or specified,

anchor bolts for items of equipment mounted on baseplates shall be long enough to provide adequate anchorage into structural concrete.

e. Structural steel supports and miscellaneous steel required for supporting and/or hanging equipment and piping furnished under this Division shall be provided and installed by General Contractor.

f. All foundations, anchor pads, piers, thrust blocks, inertia blocks and structural steel supports shall be built to template and reinforced as required for loads imposed on them.

g. The General Contractor shall assume all responsibility for sizes, locations and design of all foundations, anchor pads, pier, thrust blocks, inertia blocks, curbs and structural steel supports.

7. Shop Painting:

a. All steel and iron surfaces shall be protected by suitable paint or coatings applied in the shop. Surfaces which will be inaccessible after assembly shall be protected for the life of the equipment. Exposed surfaces shall be finished smooth, thoroughly cleaned, and filled as necessary to provide a smooth uniform base for painting. Electric motors, speed reducers, starters, and other self-contained or enclosed components shall be shop primed or finished with a high-grade oil resistant enamel suitable for coating in the field with an alkyd enamel. Coatings shall be suitable for the environment where the equipment is installed.

b. Surfaces to be painted after installation shall be prepared for painting as recommended by the paint manufacturer for the intended service, and then shop painted with one or more coats of the specified primer. Unless otherwise specified, the shop primer for steel and iron surfaces shall be Cook "391-N-167 Barrier Coat", Koppers "No. 10 Inhibitive Primer", or equal.

c. Machined, polished, and nonferrous surfaces which are not to be painted shall be coated with rust-preventive compound, Houghton "Rust Veto 344", Rust-Oleum "R-9", or equal.

8. Nameplates: General Contractor shall provide equipment identification nameplates for each item of equipment. Nameplates shall be 1/8-inch Type 304 stainless steel and shall be permanently fastened. Plates shall be fastened using round head metallic drive screws, or where metallic drive screws are impractical, with stainless steel pop rivets. Metallic drive screws shall be brass or stainless steel, Type V and No. 8 by 3/8-inch long. Names and/or equipment designations shall be engraved on the plates and the engraving painted with a primer and black paint system compatible with stainless steel. General Contractor shall submit a list of proposed names and designations for review prior to fabrication of nameplates. At a minimum, each nameplate shall include equipment

manufacturers name, year of manufacture, serial number and principal rating data.

9. Pipe Identification:

   a. All pipe (except underground) shall have code letters and flow arrows painted as per specification Sections 15075 – Identification for Plumbing Piping and Equipment, The General Contractor shall ensure that the pipes are properly marked.

   b. Underground pipe and tube: Pipe and tube shall be located by laying 2-inch wide plastic tape continuously along the run of pipe or tube. Where possible, color of tape shall be consistent with the color of bands on interior pipe and as approved by the Engineer, or shall bear an imprinted identification of the line.

      i. Location: Tape shall be laid approximately 12 inches below ground surface and directly over pipe location.

      ii. Manufacturer: Tape shall be an inert plastic film highly resistant to alkaline, acids or other destructive chemical components likely to be encountered in soils and shall be Terra Tape as manufactured by Griffolyn Company, or underground warning tape by Seton Name Plate Corporation or equal. Pipe of PVC shall be protected with a detectable tape with a metallized foil core and shall be Terra Tape "D" or equal.

10. Valve Identification: On all valves, except shut-off valves located at a fixture or piece of equipment, the General Contractor shall provide a coded and numbered tag attached with brass chain and/or brass "S" hooks.

   a. Tag Types:

      i. Tags for valves on pipe and tube lines conducting hot medium (steam, condensate, hot water, etc.) shall be brass or anodized aluminum.

      ii. Tags for all other valves shall be Type 304 stainless steel.

      iii. Square tags shall be used to indicate normally closed valves and round tags shall indicate normally open valves.

   b. Coding: In addition to the color coding, each tag shall be stamped or engraved with wording or abbreviations to indicate the line service. All color and letter coding shall be approved by the Engineer.

   c. Valve Schedule: The General Contractor shall provide a typewritten list of all tagged valves giving tag shape, letter code and number, the valve size, type, use and general location within building.

11. Noise Attenuation and Control:

a. Unless otherwise specified, the maximum permissible noise level for a complete installed piece of equipment located within or outside a structure shall not exceed 85 dB at 3 feet. A complete piece of equipment includes the driver and driven equipment, plus any intermediate couplings, gears, and auxiliaries. All equipment provided herein that is specified to be factory and field tested shall be tested as specified herein for noise generation at the equipment manufacturer's expense.

b. Maximum permissible noise (sound pressure) levels shall be in decibels as read on the "A" weighting scale of a standard sound level meter (dB); all measurements shall be made in relation to a reference pressure of 0.0002 microbar. Measurements of emitted noise levels shall be made on a sound level meter meeting at least the Type 2 requirements set forth in ANSI S1.4, Specification for Sound Level Meters. The sound level meter shall be set on the "A" scale and to slow response. Unless otherwise specified for a particular piece of equipment, the point of measurement of sound level shall be made at the specified distance from any major surface along the entire perimeter and at midheight of the piece of equipment, or at the specified distance from an outer major surface encompassing the sound source including inlets or outlets.

12. Fire Hazard Rating:

a. All piping, duct work, and equipment insulation, fastener, and jacketing materials shall have a fire hazard rating not to exceed 25 for flame spread, 50 for fuel contributed, and 50 for smoke developed. Rating shall be determined by ASTM Designation E84, "Surface Burning Characteristics of Building Materials". Corresponding ratings determined by Underwriters' Laboratories, Inc., UL-723, "Test Method for Fire Hazard Classification of Building Materials", will also be acceptable.

b. Flameproofing treatments will not be acceptable.

13. Heating, Ventilation and Domestic Plumbing Equipment:

a. Interchangeability: In all design and purchasing, interchangeability of items of equipment, subassemblies, parts, motors, starters, relays, and other items is essential. All similar items shall be of the same manufacturer, type, model, and dimensions.

2.03 ACCESSORIES:

A. Special Tools and Accessories: Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

2.04 SPARE PARTS:

A. Spare parts for certain equipment provided under Divisions 11, 13, 14, 15, and 16 have been specified in the pertinent sections of the specifications. The General Contractor shall collect and store all spare parts in an area to be designated by the Engineer. In addition, the General Contractor shall furnish to the Engineer an inventory listing of all spare part, the equipment they are associated with, and the name and address of the supplier.

B. Maintenance Materials:

1. All grease, oil, and fuel required for testing of equipment shall be furnished with the respective equipment. The Engineer shall be furnished with a year's supply of required lubricants including grease and oil of the type recommended by the manufacturer with each item of equipment supplied.

2.. The General Contractor shall be responsible for changing the oil in all drives and intermediate drives of each mechanical equipment after initial break-in of the equipment, which in no event shall be any longer than three weeks of operation.

2.05 QUALITY CONTROL:

A. General Contractor shall follow Manufacturer's and Supplier's recommended product quality control specifics as required for project.

PART 3 EXECUTION

3.01 PREPARATION (Not Applicable)

3.02 INSTALLATION:

A. Installation: Equipment shall not be installed or operated except by, or with the guidance of, qualified personnel having the knowledge and experience necessary for proper results. When so specified, or when employees of General Contractor or his subcontractors are not qualified, such personnel shall be field representatives of the manufacturer of the equipment or materials being installed.

1. The General Contractor shall have on site sufficient proper construction equipment and machinery of ample capacity to facilitate the work and to handle all emergencies normally encountered in work of this character. To minimize field erection problems, mechanical units shall be factory assembled when practical.

2. Equipment shall be erected in a neat and workmanlike manner on the foundations and supports at the locations and elevations shown on the Drawings, unless otherwise directed by the Engineer during installation.

3. All equipment shall be installed in such a manner as to provide access for routine maintenance including lubrication.

4. For equipment such as pumping units, which require field alignment and connections, the General Contractor shall provide the services of the equipment manufacturer's qualified mechanic, millwright, machinist, or authorized representative, to align the pump and motor prior to making piping connections or anchoring the pump base.

5. Equipment of a portable nature which require no installation shall be delivered to a location designated by the Engineer.

B. Tolerances: Precision gauges and levels shall be used in setting all equipment. All piping and equipment shall be perfectly aligned, horizontally and vertically. Tolerances for piping and equipment installation shall be 1/2 inch to 30 ft horizontal and vertically. All valves and operators shall be installed in the position shown on the Contract Drawings or as directed by the Engineer, if not shown.

C. Alignment and Level: The equipment shall be brought to proper level by shims (1/4 inch maximum). After the machine has been leveled and aligned, the nuts on the anchor bolts shall be tightened to bind the machine firmly into place against the wedges or shims. Grouting shall be as specified in Section 03600 – Grout.

D. Grouting: The grout shall be tamped into position with a board, steel bar, or other tool. Tamping should not be so hard as to raise or otherwise displace the plate.

E. Contact of Dissimilar Metals: Where the contact of dissimilar metal may cause electrolysis and where aluminum will contact concrete, mortar, or plaster, the contact surface of the metals shall be separated using not less than one coat of zinc chromate primer and one heavy coat of aluminum pigmented asphalt paint on each surface.

F. Cutting and Patching: All cutting and patching necessary for the work shall be performed by the General Contractor.

G. Operation: All equipment installed under this Contract, including that furnished by Engineer or others under separate contract, shall be placed into successful operation according to the written instructions of the manufacturer or the instructions of the manufacturer's field representative. All required adjustments, tests, operation checks, and other startup activity shall be provided.

3.03 INSPECTION AND TESTING:

A. Where the specifications require observation of performance tests by the Engineer, such tests shall comply with the quality assurance paragraph in this section.

3.04 START-UP AND INSTRUCTION:

A. Services Furnished Under This Contract:

1. An experienced, competent, and authorized representative of the manufacturer of each item of equipment shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. In each case, the manufacturer's representative shall be present when the equipment is placed in

operation. The manufacturer's representative shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

2. Each manufacturer's representative shall furnish to Engineer and General Contractor, a letter of certification stating that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

3. All costs for field services shall be included in the contract amount.

END OF SECTION

SPECIFICATION REVISION INDEX

Revision No.	Revision Date	Issued for	Signatures				
			Prepared By	Reviewed By	Project Engineer	Project Manager	Client
A	11/28/2016	60% Submittal	CMF	JG	JG	STD	
B	2/15/2017	75% Submittal	CMF	JG	JG	STD	

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SECTION 15044

PRESSURE TESTING OF PLANT PIPING

PART 1 GENERAL

1.01 DESCRIPTION:

A. Scope of Work: This section specifies the leakage testing requirements for plant piping.

B. Related Work Described Elsewhere

1. Process mechanical equipment are included under Division 11.

2. Mechanical piping, valves, pipe hangers, accessories, and appurtenances are included under Division 15.

1.02 QUALITY ASSURANCE:

A. Test Pressures: Test pressures for the various services and types of piping shall be as shown in Table 15044- A and at a minimum shall be 1.5 times the working pressure.

1.03 SUBMITTALS:

A. Materials and Shop Drawings (Not Applicable)

B. Additional Information:

1. Testing Plan: Submit prior to testing and include at least the information that follows:

a. Testing dates.

b. Piping systems and section(s) to be tested.

c. Test type.

d. Method of isolation.

e. Calculation of maximum allowable leakage for piping section(s) to be tested.

2. Certifications of Calibration: Testing equipment.

3. Certified Test Report.

4. Testing Records:

a. Provide a record of each piping installation during the testing. These records shall include:

i. Date of test.

ii. Identification of pipeline tested or retested.

iii. Identification of pipeline material.

iv. Identification of pipe specification.

v. Test fluid.

vi. Test pressure.

vii. Remarks: Leaks identified (type and location), types of repairs, or corrections made.

viii. Certification by General Contractor that the leakage rate measured conformed to the specifications.

ix. Signature of Engineer's representative witnessing pipe test.

b. Submit five (5) copies of the test records to the Engineer's representative upon completion of the testing.

PART 2 PRODUCTS

2.01 GENERAL:

A. Testing fluid shall be clean water for all piping except air service and shall be of such quality to prevent corrosion of materials in piping system for all hydrostatic tests. Air piping shall be tested using compressed air.

2.02 MATERIALS AND EQUIPMENT

A. Provide pressure gauges, necessary bracing and restraint, test plugs, pipes, bulkheads, pumps, and meters to perform the hydrostatic and pneumatic testing.

PART 3 EXECUTION

3.01 PREPARATION:

A. Pipes shall be in place and anchored before commencing pressure testing.

B. Conduct hydrostatic and pneumatic tests on exposed and aboveground piping after the piping has been installed and attached to the pipe supports, hangers, anchors, expansion joints, valves, and meters.

C. Before conducting hydrostatic tests, flush pipes with water to remove dirt and debris. For pneumatic tests, blow air through the pipes.

D. Test new pipelines which are to be connected to existing pipelines by isolating the new line from the existing line by means of pipe caps, special flanges, or blind flanges. After the new line has been successfully tested, remove caps or flanges and connect to the existing piping.

E. Conduct hydrostatic tests on buried pipe after the trench has been completely backfilled. The pipe may be partially backfilled and the joints left exposed for inspection for an initial leakage test. Perform the final test, however, after completely backfilling and compacting the trench.

F. Chlorine Piping: Test, dry, and clean in accordance with requirements of Chlorine Institute Pamphlet 6.

G. New Piping Connected to Existing Piping: Isolate new piping with grooved-end pipe caps, spectacle blinds, blind flanges, or as acceptable to Engineer.

H. Items that do not require testing include: Piping between wet wells and wetwell isolation valves, equipment seal drains, tank overflows to atmospheric vented drains, and tank atmospheric vents.

I. Gravity Piping:

1. Perform testing after service connections, manholes, and backfilling have been completed between stations to be tested.

2. Determine groundwater level at time of testing by exploratory holes or other method acceptable to Engineer.

J. Pressure Test:

1. All tests shall be made in the presence of and to the satisfaction of the Engineer and also, to the satisfaction of any local or state inspector having jurisdiction.

    a. Provide not less than three (3) days notice to the Engineer, and the authority having jurisdiction when it is proposed to make the tests.

    b. Any piping or equipment that has been left unprotected and subject to mechanical or other injury in the opinion of the Engineer shall be retested in part or in whole as directed by the Engineer.

    c. The piping systems may be tested in sections as the work progresses, but no joint or portion of the system shall be left untested.

2. All elements within the system that may be damaged by the testing operation shall be removed or otherwise protected during the operation.

3. Repair all damage done to existing or adjacent work or materials due to or on account of the tests.

3.02 INSTALLATION (Not Applicable)

3.03 INSPECTION AND TESTING:

A. Hydrostatic Testing of Aboveground or Exposed Piping: The maximum filling velocity shall be 0.25 feet per second, applied over full area of pipe. Open vents at high points of the piping system to purge air while the pipe is being filled. Subject the piping system to the test pressure indicated. Maintain the test pressure for a minimum of four (4) hours. Examine joints, fittings, valves, and connections for leaks. The piping system shall show no leakage or weeping. Correct leaks and retest until no leakage is obtained.

B. Hydrostatic Testing of Buried Piping:

1. Test after backfilling has been completed. Expel air from piping system during filling.

2. Where any section of the piping contains concrete thrust blocks or encasement, do not make the pressure test until at least 10 days after the concrete has been poured. When testing mortar-lined piping, fill the pipe to be tested with water and allow it to soak for at least 48 hours to absorb water before conducting the pressure test.

3. Apply and maintain the test pressure by means of a hydraulic force pump. Maintain the test pressure for a minimum duration of four (4) hours. After the test pressure is reached, use a meter to measure the additional water added to maintain the pressure during the four hours. This amount of water is the loss due to leakage in the piping system. The allowable leakage rate is defined by the formula.

$$L = \frac{SD(P)^{1/2}}{133{,}200}$$

in which:

L	=	allowable leakage (gallons/hour) during the test period.
S	=	length of pipe, in feet
D	=	diameter of the pipe (inches)
P	=	specified test pressure (psig)

3. Repair and retest any pipes showing leakage rates greater than that allowed.

C. Pneumatic Test For Pressure Piping:

1. Do not perform on PVC or CPVC pipe.

2. Fluid: Oil-free, dry air.

3. Procedure:

a. Apply preliminary pneumatic test pressure of 25 psig maximum to piping system prior to final leak testing, to locate visible leaks. Apply soap bubble mixture to joints and connections, examine for leakage.

b. Correct visible leaks and repeat preliminary test until visible leaks are corrected.

c. Gradually increase pressure in system to half of specified test pressure. Thereafter, increase pressure in steps of approximately one-tenth of specified test pressure until required test pressure is reached.

d. Maintain pneumatic test pressure continuously for minimum of 10 minutes and for such additional time as necessary to conduct soap bubble examination for leakage.

e. Correct visible leakage and retest as specified.

4. Allowable Leakage: Piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of leakage.

5. After testing and final cleaning, purge with nitrogen those lines that will carry flammable gases to assure no explosive mixtures will be present in system during filling process.

D. Hydrostatic Test For Gravity Piping:

1. Testing Equipment Accuracy: Plus or minus 1/2 gallon of water leakage under specified conditions.

2. Maximum Allowable Leakage: 0.16 gallon per hour per inch diameter per 100 feet. Include service connection footage in test section, subjected to minimum head specified.

3. Gravity Sanitary and Roof Drain Piping: Test with 15 feet of water to include highest horizontal vent in filled piping. Where vertical drain and vent systems exceed 15 feet in height, test systems in 15-foot vertical sections as piping is installed.

4. Exfiltration Test:

a. Hydrostatic Head:

i. At least 6 feet above maximum estimated groundwater level in section being tested.

ii. No less than 6 feet above inside top of highest section of pipe in test section, including service connections.

5. Infiltration Test:

   a. Groundwater Level: At least 6 feet above inside top of highest section of pipe in test section, including service connections.

6. Piping with groundwater infiltration rate greater than allowable leakage rate for exfiltration will be considered defective even if pipe previously passed a pressure test.

7. Defective Piping Sections: Replace or test and seal individual joints, and retest as specified.

E. Test Pressure:

1. All pipe shall be tested at pressures shown in Table 15044-A. If not listed in Table 15044-A the minimum test pressure shall be 1.5 times the normal working pressure of the pipe.

TABLE 15044-A

PIPING PRESSURE TEST SCHEDULE

Service	Maximum Working Pressure (psig)	Test Pressure (psig)
All process piping	update	update

LEGEND: WCH = Water Column Height

END OF SECTION

SPECIFICATION REVISION INDEX

Revision No.	Revision Date	Issued for	Signatures				
			Prepared By	Reviewed By	Project Engineer	Project Manager	Client
A	11/28/2016	60% Submittal	PP	DS	JG	STD	
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SECTION 15045

PRESSURE TESTING OF INFLUENT AND EFFLUENT PIPING

PART 1 GENERAL

1.01 Description: The information in this specification applies to the testing of metallic Category D and Normal fluid service process piping systems constructed to ASME B31.3 “Process Piping”. Nonmetallic piping and other fluid service categories have additional requirements.

A. Section Includes:

1. General
2. Test Preparation
3. Hydrostatic Leak Test
4. Test Pressure
5. Examination for Leaks
    a. Pipe
    b. Victaulic Couplings
    c. Victaulic Fittings
    d. Victaulic Valves
    e. Victaulic Specialties
    f. Victaulic Tooling
6. Execution

B. Submittals:

1. Victaulic products shall be shown on drawings and product submittals and shall be specifically identified with the applicable Victaulic style or series number.

C. References:

1. American Society for Testing Materials (ASTM)
    a. ASTM A-53 – Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.

2. American Society of Mechanical Engineers
    a. ASME B16.9 – Factory Made Wrought Butt Welded Fittings
    b. ASME B31.1 – Chemical Plant and Petroleum Refining Piping
    c. ASME B31.9 – Building Services Piping

3. American Water Works Association
    a. AWWA C-606 – Grooved and Shouldered Joints

PART 2 PRODUCTS

2.01 General:

A. Testing fluid shall be clean water for all piping except air service and shall be of such quality to prevent corrosion of materials in piping system for all hydrostatic tests. Air piping shall be tested using compressed air.

2.02 Materials and Equipment

A. Provide pressure gauges, necessary bracing and restraint, test plugs, pipes, bulkheads, pumps, and meters to perform the hydrostatic and pneumatic testing.

PART 3 EXECUTION

3.01 Test Preparation:

A. All Code and design required examinations shall be complete prior to testing

B. A preliminary walk-down of the piping to be tested shall be made. Test personnel shall correct and/or identify test boundaries, any problems, incomplete items, joint access, fill points, vent points and any scaffolding required.

C. All joints, including welds and mechanical joints are to be left un-insulated and exposed for examination during the test, except that joints previously tested may be insulated or covered.

D. Hangers and supports shall be placed in the proper position prior to the filling of the system to be tested.

E. Piping designed for vapor or gas shall be provided with additional temporary supports, if necessary to support the weight of the test liquid, as designated by the designer. Spring hangers should be placed in the locked position.

F. Expansion joints shall be provided with temporary restraint if required for additional pressure load under test, or shall be isolated from the test.

G. The test personnel shall assure that the components (e.g. instruments, valves, etc.) that are not to be subjected to the pressure test, are either disconnected from the piping or isolated by blind flanges or other means during the tests. Valves may be used for isolation, provided the valve (including the closure mechanism) is suitable for the proposed test pressure.

H. A flanged joint at which a blank is inserted to isolate other equipment during the test need not be examined for leaks. These joints should be leak tested during initial service.

I. If a pressure test is to be maintained for a period of time and the test liquid in the system is subject to changes in temperature, precautions shall be taken to avoid excessive pressure due to thermal expansion or freezing.

J. A preliminary air test at not more than 25 psi gage pressure may be made prior to hydrostatic test in order to locate major leaks.

K. A test record shall be made for each leak test. The record shall include the following:

1. Date of test
2. Identification of piping to be tested (test boundaries)
3. Test fluid
4. Test pressure
5. Certification of the examiner
6. Following leak testing, the piping system should be cleaned, and dried if necessary. Refer to Appendix K for cleaning techniques.
7. Prior to in-service leak test, the piping system should be cleaned, and dried if necessary.
8. During Hydrostatic testing or in-service leak testing, strainers should be used to protect equipment against the introduction of construction debris or dirt.

3.02 Hydrostatic Leak Test:

A. Test Fluid

1. The test fluid shall be water unless there is a possibility of damage due to freezing, or if the process or piping material would be adversely affected by water. In that case other suitable test fluids may be used. Special precautions are required if the test fluid is toxic or flammable.

2. The temperature of the test fluid should be no less than 40F in piping systems subject to brittle fracture (i.e. carbon steel).

3. If the test fluid temperature produces condensation on the piping exterior surface, the water shall be heated to a temperature above the dew point or the test shall be postponed to a time when the dew point temperature has changed sufficiently such that condensation will not occur on the piping exterior surface.

4. Material and test water temperature shall be approximately equal prior to pressurizing the system.

5.) High points in the system shall be vented so that air will be displaced while the system is being filled with the test fluid.

6. The operator shall take adequate measures to ensure that the piping system is not over-pressurized during hydrostatic testing. Adequate measures include a relief valve, or a dedicated operator to monitor pressure, or dual pressure regulators, etc.

B. Test Pressure

1. The minimum hydrostatic test pressure for metallic piping shall be per the following equation:

   PT = 1.5 x PD x ST/SD where:

   PT = minimum test gage pressure
   PD = internal design gage pressure
   ST = allowable stress value at test temperature
   SD = allowable stress value at design temperature
   Note: The maximum allowable value of ST/SD is 6.5

2. When a maximum test pressure is specified, the test pressure shall not exceed this amount.

3. When no maximum test pressure is specified, the test shall not be greater than 110% of the minimum.

4. When using water, static head due to differences in the elevation of the top of the piping system and the elevation of the test gage shall be accounted for in pressuring the piping system to be tested by the following equations:

   SH (psi) = (HE - GE) x 0.433 PST = PT + SH where:

   HE = high point elevation (ft)
   GE = gage point elevation (ft)
   SH = static head (psi)
   PST = minimum test gage pressure corrected for static head 0.433 = conversion factor (ft of waster to psi)

5. Pressure gages should be connected directly to the piping. Calibrated pressure gages shall be used in all Code testing. Pressure gage range should exceed the intended test pressure by approximately double but in no case should the range be less than one and one-half (1 ½) times the test pressure.

C. Hydrostatic Testing of Piping with Vessels as a System

1. Where the test pressure of piping attached to a vessel is the same as or less than the test pressure for the vessel, the piping may be tested with the vessel at the test pressure of the piping.

2. Where the test pressure of the piping exceeds the vessel test pressure and isolation is not considered practicable, the piping and the vessel may be tested together at the test

pressure of the vessel, if approved by the design authority. The vessel test pressure must not be less than 77% of the piping test pressure.

D. Examination for Leaks

1. Test personnel shall ensure the hydrostatic pressure is maintained for sufficient time to determine if there are any leaks. A minimum time of 10 minutes is required by Code. After the hydrostatic pressure time has been satisfied, all joints shall examined visually for leaks.

2. Examination shall be made of all welds and mechanical joints. There shall be no visible evidence of leakage. Welds and joints previously tested need not be examined for leaks.

3. Leakage detected in welded joints shall be repaired by draining, repair welding, non-destructively examining in accordance with original requirements, and re-tested to the original test pressure.

4. Mechanical joint leakage at permanent joints shall be repaired, examined in accordance with original requirements, and re-tested to the original test pressure.

END OF SECTION

SPECIFICATION REVISION INDEX

Revision No.	Revision Date	Issued for	Signatures				
			Prepared By	Reviewed By	Project Engineer	Project Manager	Client
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SECTION 15051

PROCESS AND UTILITY PIPING, FITTINGS AND ACCESSORIES

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope of Work: The Work included in this Section consists of furnishing all labor, equipment, and materials and performing all operations necessary for the construction or installation of all process and utility piping and appurtenances complete and ready for operation as shown on the Drawings and specified herein.

B. Related Work Described Elsewhere

1. Shop Drawings: Section 01330.

2. Materials and Equipment: Section 01600.

3. Operating and Maintenance Manuals: Section 01730.

4. Warranties: Section 01740.

5. Concrete: Division 3.

6. Metals: Division 5.

7. Painting: Division 9.

8. Equipment: Division 11.

9. Special Construction: Division 13.

10. Pressure Testing of Piping: Section 15044.

11. Supports and Anchors: Section 15060.

1.02 QUALITY ASSURANCE

A. Construction Requirements: For underground utilities, changes in horizontal alignment of less than 11-1/4 degrees may be achieved through the use of allowable pipe deflection in lieu of fittings shown on the Drawings at the General Contractor's option, but subject to approval of the Engineer as to layout. Said deflection shall not exceed 75 percent of the maximum allowable deflection stated in the pipe manufacturer's installation instructions.

B. Pipe Inspection: The General Contractor shall obtain from the pipe manufacturers a certificate of inspection stating that the pipe and fittings supplied for this Contract have been inspected at the plant and that they meet the requirements of these Specifications.

All pipe and fittings shall be subject to visual inspection at time of delivery and also just before they are lowered into the trench to be laid. Joints or fittings that do not conform to these Specifications will be rejected and must be removed immediately by the General Contractor. The entire product of any plant may be rejected when, in the opinion of the Engineer, the methods of manufacture fail to secure uniform results, or where the materials used are such as to produce inferior pipe or fittings.

1.03 SUBMITTALS

A. Shop Drawings

1. The General Contractor shall prepare and submit for approval a complete detail drawing of all valves in accordance with the requirements of the General Provisions and Division 1. At a minimum, the submittal shall show all proposed material types to be used as well as interior and exterior coating manufacture, coating type, and proposed minimum dry film thickness.

2. In general, the following Shop Drawings shall be submitted to the Engineer for approval prior to construction:

a. Mill test certificates or certified test reports on pipe and fittings.

b. All valves, including butterfly and check valves.

c. Electric motor operators.

d. Joint lubricant.

e. Detailed piping layout drawings and pipe laying schedule (see below).

f. Temporary plug and anchorage system for hydrostatic pressure test.

2. Tabulated layout schedule for each pipe system including:

a. Pipe elevation at each change of alignment.

b. The limits of each reach of pipe thickness class.

c. Locations of valves and other mechanical equipment.

d. Methods and locations of supports.

e. Details of special elbows and fittings.

3. Full calculations for each size of motor operator indicating forces, full load and locked rotor current and horsepower shall be furnished to the Engineer for approval.

4. A separate shop drawing submittal will be required for each major item listed above and for each different type of an item within a major item. For example,

separate submittals will be required for ductile iron pipe, butterfly and check valves, electric motor operators, etc. All submittals shall be in accordance with the General and Special Conditions and Section 01330 – Shop Drawings.

B. Acceptance of Material

1. The General Contractor shall furnish an affidavit of compliance certified by the pipe manufacturer that the pipe, fittings, and specials furnished under this Contract comply with all applicable provisions of current AWWA and ASTM Standards and these Specifications. No pipe or fittings will be accepted for use in the Work on this project until the affidavit has been submitted and approved by the Engineer.

2. The Engineer reserves the right to sample and test any pipe or fitting after delivery and to reject all pipe and fittings represented by any sample which fails to comply with the specified requirements.

C. Operation and Maintenance Manuals: Submit operation and maintenance manuals for applicable components requiring periodic maintenance and/or explanation of operation. Manuals shall be prepared in accordance with Section 01730 – Operations and Maintenance Data. Information shall include:

1. Detailed assembly drawings, clear and concise instructions for operating, adjusting, overhauling, troubleshooting and, other maintenance. Include shop drawings previously submitted and approved with all corrections made.

2. A complete lubrication schedule including lubricant types, grades, and recommended frequency of lubrication.

3. A list of parts for all products with catalog numbers and all data necessary for ordering replacement parts. Such instructions and parts lists shall be prepared for the specific product furnished and shall not refer to other types or models.

1.04 DELIVERY, STORAGE AND HANDLING

A. Pipe, fittings, valves, and accessories shall be handled in a manner that will ensure a sound undamaged condition during shipping, delivering and installing.

B. Particular care shall be taken not to injure the pipe coating and linings.

C. Insides of valves and piping shall be kept free of dirt and debris.

1.05 JOB CONDITIONS

A. All necessary precautions shall be taken to prevent the entrance of mud, sand, or other obstructing matter into the pipelines. If on completion of the work any such materials have entered the pipelines, it must be cleaned as directed by the Engineer so that the entire system will be left clean and unobstructed.

PART 2 PRODUCTS

2.01 GENERAL

A. All references to “stainless steel” or “SS” shall mean 316 stainless steel unless otherwise specified.

B. All valves of the same type shall be from a single manufacturer. Parts of valves of the same type and size shall be interchangeable.

C. All valves shall be carefully erected in their respective positions, free from all distortion and strain, and shall be packed and left in satisfactory operating conditions.

D. All valves shall be given hydrostatic shop pressure test at twice the working pressure specified. The valves shall be tested, first by applying the hydrostatic pressure with the valve open and then with the valve closed. The valves shall be tight and secure under the test pressure.

2.02 High Density Polyethylene Pipe (HDPE) (Pressure Pipe)

A. Manufacturers:
   1. Performance Pipe (Driscopipe) – Chevron/Phillips 66
   2. Or approved equal

B. Pipe and Fittings
   1. ASTM D3350: PE 3408 high density polyethylene, cell classification 345434C or 345434E
   2. ASTM D1248: Type III, Class B or Class C, Category 5, Grade P34
   3. Standard grade ratings: 1,600 psi at 73 degrees F
   4. Pure material except for materials obtained from manufacturer's own production of the same formulations, no rework compounds are acceptable
   5. Polyethylene resin compound containing antioxidants

C. Accessories
   1. Pipe-joining equipment:
      a. Hydraulic pressure controls for fusing the two pipe ends together
      b. Electric or gasoline engine-powered facing unit to trim irregularities from pipe ends
      c. Electrically heated and thermostatically controlled heating plate with temperature monitoring gauge
      d. External appearance of fusion head: Smooth without significant juncture groove

D. Fabrication

1. Polyethylene pipe: ASTM F714, indicate on pipe:
    a. Homogeneous throughout, free of visible cracks, holes, foreign material, blisters, or other deleterious faults

2. Polyethylene fittings, custom fabrications and manholes:
    a. Molded or fabricated by pipe manufacturer or authorized representative
    b. Thermal butt fusion outlets made to same outside diameter and wall thickness dimensions and tolerances as pipe to which joining is intended
    c. Construct custom fabrications and manholes to shop drawings accepted by Engineer

3. Molded fittings: ASTM D3261, indicate on fittings

4. Fabricated fittings: Made by thermal fusion joining specially machined shapes cut from pipe, polyethylene sheet stock, or molded fittings

5. Polyethylene flange adapters:
    a. Fabricate with sufficient through bore length to be clamped in a thermal butt fusion joining machine without the use of stub-end holder
    b. Machine sealing surface with series of small v-shaped grooves. Provide grooves for gasketless sealing and to restrain gasket against blow-out

6. Service identification stripes:
    a. Provide permanent identification by co-extruding four equally spaced color stripes into pipe outside surface
    b. Use striping material as same material as pipe material except for color
    c. Use the following stripe colors to identify pipe service:
        i. Yellow - gaseous fuels
        ii. Blue - potable water
        iii. Green - non-potable or raw water, wastewater, sewage
        iv. Red - fire main

2.03 Stainless Steel Pipe (SS) (Pressure Pipe)

A. Pipe and fittings:

1. Schedule 10S with flanged or welded fittings per Drawings: ASTM A778, “as-welded” grade, Type 316L, pickled and passivated.

B. Ball Valves

1. MSS SP 110, ASTM B16
2. Working Pressure: As indicated on valve schedule.
3. Maximum Fluid Temperature: 80 degrees C.
4. Two-piece stainless steel body.
5. 316 stainless-steel ball.
6. Full port, PTFE seats.
7. Blowout-proof stem.
8. End Connections: Flanged.

9. Operator: Hand lever.

C. Accessories:
1. Bolting: Type 316 stainless steel, ASTM A320/A320M Grade B8M hex head bolts and ASTM A194/A194M Grade 8M hex head nuts.
2. Gaskets
   a. Gaskets shall be PTFE, model Flexitallic Sigma 600 or approved equal.
   b. Blind flanges shall be gasketed covering entire inside face with gasket cemented to blind flange.

PART 3 EXECUTION

3.01 INSPECTION

A. All pipe, fittings, valves, and other material shall be subject to inspection and approval by the Engineer after delivery, and no broken, cracked, imperfectly coated, or otherwise damaged or unsatisfactory material shall be used. When a defect or crack is discovered, the damaged portion shall not be installed. Cracked pipe shall have the defect cut off at least 12 inches from the break in the sound section of the barrel.

3.02 GENERAL INSTALLATION REQUIREMENTS

A. Pipe, fittings, and accessories shall be installed as shown or indicated on the Drawings.

B. All connections to existing piping systems shall be made as shown or indicated on the Drawings after consultation and cooperation with authorities of the Engineer. Some such connections may have to be made during off-peak hours (late night or early morning).

C. Above-Ground and Exposed Piping: Piping shall be cut accurately to measurements established at the job site and shall be worked into place without springing or forcing, properly clearing all equipment access areas and openings. Changes in sizes shall be made with appropriate reducing fittings. Pipe connections shall be made in accordance with the details shown and manufacturer's recommendations. Open ends of pipelines shall be properly capped or plugged during installation to keep dirt and other foreign material out of the system. Pipe supports and hangers shall be provided where indicated or as required to insure adequate support of the piping.

D. Bedding and backfill for underground piping:
1. Perform work under provisions of Section 02200
2. Lay pipe on grade and on stable foundation
3. Remove unstable or mucky trench bottom soils. Place 6 inches of acceptable foundation material to pipe bottom grade
4. Remove excess groundwater
5. Excavate trench 6 inches below pipe bottom grade where cut in rock or stony soil. Bring back to grade with suitable bedding material
6. Remove all ledge rock, boulders and large stones
7. Compact pipe embedment a minimum of 6 inches above pipe crown

8. Place and compact final backfill to finished grade. Use native soils without debris, stones, boulders, clumps, frozen clods or the like larger than 8 inches in their largest dimension

3.03 INSTALLATION OF HDPE

A. Install in accordance with manufacturer's instructions and ASTM F585

B. Large diameter fabricated fittings:
   1. Butt fuse fabricated directional fittings 16 inches IPS and larger to end of pipe
   2. Connect flanged directional outlet fittings in the trench

C. Mechanical joint and flange connections:
   1. Install per manufacturer's instructions
   2. Center and align flange faces to each other before assembling and tightening bolts
   3. Do not use flange bolts to draw flanges into alignment
   4. Lubricate bolt threads and fit flat washers under flange nuts
   5. Evenly tighten according to acceptable tightening pattern and torque step instructions of manufacturer
   6. Re-tighten flange connections one hour after initial assembly following the tightening pattern and torques step instructions
   7. Use final tightening torque of 100 ft-lbs or less as instructed by manufacturer

3.04 MANUFACTURER'S FIELD SERVICES

A. Provide training of General Contractor's personnel and Engineer's authorized representative on butt fusion procedures for making heat fusion joints

B. Certify that training was received not more than 12 months before commencing construction

3.05 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed under provisions of Section 01400 in presence and to satisfaction of Engineer

B. Butt Fusion Testing:
   3.05.B.1 Perform trial fusion for first fusion of each day butt fusions are to be made
   3.05.B.2 Allow trial fusion to cool completely and cut out fusion test strap with fusion in center
   3.05.B.3 Test strap length: 12 inch minimum, or 30 times wall thickness
   3.05.B.4 Test strap width: 1 inch minimum, or 1.5 times wall thickness
   3.05.B.5 Bend test strap until ends of strap touch
   3.05.B.6 If fusion fails at joint, make a new trial fusion, cool and test
   3.05.B.7 Do not proceed with butt fusion of pipe to be installed until trial fusion passes the bent strap test
   3.05.B.8 Submit passing bent strap samples as required herein

3.06 HYDROSTATIC PRESSURE AND LEAKAGE TESTING – See Section 15044, Pressure Testing of pipes.

3.07 OBTAINING WATER FOR TESTING AND FLUSHING

A. The water supply for testing shall be Stabilized Lake Mead Water (SLMW).

B. The water supply shall be protected with an air gap or a reduced pressure principle backflow preventer approved by the Engineer, if potable water is used for testing and flushing.

B. To obtain water service during construction, the General Contractor shall be required to install a temporary water meter, if public supply is available. The piping, fittings, backflow preventer, and appurtenances required for the temporary construction water service shall be supplied by the General Contractor.

C. The General Contractor shall coordinate with the Engineer for temporary construction water service connection, usage, and flushing.

3.08 MAIN CLEANING AND FLUSHING

A. Following the hydrostatic and leakage tests, all piping provided under this contract shall be cleaned and flushed to remove sand, loose dirt, and other debris. Air service lines shall be flushed using air. Other pipes shall be flushed using water. Flushing velocity shall be a minimum of 2.5 fps. Flushing shall continue until clean water flows from the pipe. However, the General Contractor shall endeavor to use the minimum amount of flushing water required to complete the work.

END OF SECTION

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SPECIFICATION REVISION INDEX

Revision No.	Revision Date	Issued for	Signatures				
			Prepared By	Reviewed By	Project Engineer	Project Manager	Client
A	11/28/2016	60% Submittal	CMF	JG	JG	STD	
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SECTION 15053

CARBON STEEL PIPE AND FITTINGS

PART 1 GENERAL

1.01 DESCRIPTION:

A. This section describes materials and installation of steel pipe and fittings. This pipe may serve general purposes such as for steel casing pipe, compressed air, and miscellaneous piping applications. This section applies to piping applications which do not exceed a maximum operating pressure of 300 psi.

B. Related Work Specified Elsewhere:

1. Section 09900 – Painting

2. Section 15044 – Pressure Testing of Piping

1.02 SUBMITTALS:

A. Materials and Shop Drawings:

1. Shop drawings shall be submitted in accord with the General Provisions and the following.

2. Submit materials list showing material of pipe and fittings with ASTM reference and grade.

1.03 MEASUREMENT AND PAYMENT:

A. Payment for the work in this section shall be in accord with the General Provisions and the following:

1. Payment shall be by the linear foot for each diameter and for each pipe strength designation measured horizontally over the pipe centerline, exclusive of the distance between the inside faces of junction or other structures.

1.04 INSPECTION:

A. The Engineer reserves the right to inspect materials, production, or testing of pipe at the manufacturer's plant.

PART 2 MATERIALS

2.01 CARBON STEEL PIPE:

A. Pipe shall be black carbon steel, conforming to ASTM A 53, Type E or S, Grade A or ASTM A 135, Grade A. Pipe 12-inches in diameter and smaller shall be Schedule 40 or 80, as shown on plans, per ANSI B36.10. Pipe larger than 12-inches in diameter shall be standard weight per ANSI B36.10. Design thickness of the pipe shall be schedule 40 at a

minimum Pipe shall conform to AWWA C200, AWWA M11, with a minimum wall thickness of 0.2500 inches and as specified herein.

B. Threaded Nipples:

1. Threaded nipples shall be of the same material as the pipe. Threads shall conform to ANSI B2.1.

C. Fittings and Joints:

1. 3-Inches in Diameter and Smaller: Fittings 3-inches in diameter and smaller shall be threaded forged steel fittings (ASTM A 105) conforming to ANSI B16.11, 3,000-pound CWP may be used.

2. Buried Fittings: Fittings for buried pipe larger than 3-inches in diameter shall be flanged or butt-welded, conforming to ANSI B16.9. Material shall conform to ASTM A 234, Grade WPB. Wall thickness shall be the same as the pipe.

3. Above Ground Fittings Larger than 3-Inches in Diameter: Fittings for above ground or exposed pipe larger than 3-inches in diameter shall be grooved end or flanged, conforming to ANSI B16.9. Material shall conform to ASTM A 234, Grade WPB. Wall thickness (except for grooved ends) shall be the same as the pipe. Grooved-end joints shall comply with AWWA C606.

D. Unions:

1. Unions shall be Class 300, malleable iron (ASTM A 47, Grade 35018) brass to iron seat, conforming to ANSI B16.39. Ends shall be threaded per ANSI B1.2.01.

E. Grooved-End Couplings:

1. Grooved-end couplings shall be steel, ASTM A-536, Grade 65-45-12. Housing coating shall be Standard: Orange enamel. Gaskets shall be Grade "E" FlushSeal EPDM and shall conform to ASTM D 2000. Couplings shall be Victaulic Style 77, or Engineer-approved equal with maximum end load of 92,245 lbs. or higher.

F. Thread Lubricant:

1. Teflon thread lubricating compound or Teflon tape shall be used for threaded joints.

G. Pipe Lining and Coating:

1. Cement Mortar Lining and Coating: Where indicated on the plan exposed pipe shall be cement-mortar lined and coated in the shop per AWWA C205.

2. Exposed Piping: Piping located above ground or in vaults and structures shall be coated per Section 09900 – Painting.

H. Flanges:

1. General: Weld-neck flanges (conforming to ANSI B16.5) shall be provided for piping 3-inches in diameter and smaller to connect to flanged valves, fittings, or equipment. Slip-on or weld-neck flanges shall be provided for piping larger than 3-inches in diameter. Flanges shall match the connecting flanges on the adjacent fitting, valve, or piece of equipment. Flange material shall conform to ASTM A 105, A 181, or A 182. Flanges shall be flat face.

2. Pressure Class: The pressure class of flanges shall be determined based on the test pressures listed in Section 15044 – Pressure Testing of Piping. For test pressures 200 psi and less, Class 150 flanges, ANSI B16.5 shall be used. For test pressures greater than 200 psi, Class 300 flanges, ANSI B16.5 shall be used.

I. Bolts and Nuts for Flanges:

1. General: Bolts and nuts for flanges, shall be Type 316 stainless steel conforming to ASTM A 193 (Grade B8M) for bolts and ASTM A 194 (Grade 8M) for nuts.

2. Flange Insulation Kits: Bolts for flange insulation kits shall conform to ASTM A 193, Grade B7. Nuts shall conform to ASTM A 194, Grade 2H.

3. Washers: A washer shall be provided for each nut. Washers shall be of the same material as the nuts.

4. Dimensional Requirements: Dimensionally, bolts and nuts shall conform to the following ANSI Standards: Bolts-B18.2.1, Nuts-B18.2.2, Bolt Length-B16.5, Bolt and Nut threads-B1.1.

J. Gaskets for Flanges:

1. Gaskets shall be composed of synthetic fiber with rubber binder and shall be fullface, 1/8-inch thick Garlock 3400, Anchor 441, or ENGINEER approved equal, conforming dimensionally to ANSI B16.21. Ring gaskets extending to the inner edge of flange bolts may be used where a raised face flange is present.

K. Outlets:

1. Outlets 2-Inches in Diameter and Smaller: Outlets which are 2-inches in diameter and smaller shall be made by welding on an extra-heavy steel weld-o-letTM threaded coupling.

2. Outlets Larger than 2-Inches in Diameter: For outlets larger than 2-inches in diameter, flanged tees with flanged nozzle outlets shall be used. Tee fittings shall be fabricated in accord with the applicable portions of the latest revision of the AWWA Manual M11, "Steel Pipe — A Guide for Design and Installation".

L. Smooth radius forged steel fittings are preferred in-lieu of fabricated steel fittings.

PART 3 EXECUTION

3.01 GENERAL:

A. Fabrication:

1. Fabrication: Fabrication shall comply with ANSI B31.3, Chapter V.

2. Butt-Welded Joints: Beveled ends for butt-welding shall conform to ANSI B16.25. Slag shall be removed by chipping or grinding. Surfaces shall be clean of paint oil, rust, scale, slag, and other material detrimental to welding.

B. Weld Passes: The minimum number of passes for welded joints shall be as follows:

Steel Cylinder Thickness (inches)	Minimum Number of Passes for Welds
0.2500	2
0.2501 through 0.3750	3
0.3751 through 0.5000	4
0.5001 and greater	requires special design review

1. All welds shall be continuous and fully circumferential.

2. Welding Process: The shielded metal arc welding (SMAW) process shall be used for welding.

3. Welding Preparation: Welding preparation shall comply with ANSI B31.3, paragraph 328.4. Limitations on imperfections in welds shall conform to the requirements in ANSI B31.3, Tables 341.3.2 and 341.3.2B, and paragraph 341.4 for visual examination.

4. Weld Identification: Welds shall be identified in accord with ANSI B31.3, paragraph 328.5.

5. Cleaning Welds: Each layer of deposited weld metal, including the final pass, shall be cleaned with a power-driven wire brush prior to depositing the next layer of weld metal.

6. Welding Electrodes: Welding electrodes shall comply with AWS A5.1 or A5.5.

END OF SECTION

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SPECIFICATION REVISION INDEX

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			Prepared By	Reviewed By	Project Engineer	Project Manager	Client
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SECTION 15060

VICTAULIC STANDARD GROOVED AND
ADVANCED GROOVED (AGS) PIPING SYSTEMS

1.01 General:

A. Section Includes:

1. General
2. Materials:
   a. Pipe
   b. Victaulic Couplings
   c. Victaulic Fittings
   d. Victaulic Valves
   e. Victaulic Specialties
   f. Victaulic Tooling
3. Execution

B. Submittals:

1. Victaulic products shall be shown on drawings and product submittals and shall be specifically identified with the applicable Victaulic style or series number.

C. References:

1. American Society for Testing Materials (ASTM)
   a. ASTM A-53 – Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
   b. ASTM A-183 – Carbon Steel Track Bolts and Nuts
   c. ASTM A-234 – Standard Specification For Piping Fittings or Wrought Carbon Steel and Alloy Steel.
   d. ASTM A-449 – Quenched and Tempered Steel Bolts and Studs
   e. ASTM A-536 – Ductile Iron Castings
   f. ASTM F-1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications

2. American Society of Mechanical Engineers
   a. ASME B16.9 – Factory Made Wrought Butt Welded Fittings
   b. ASME B31.1 – Chemical Plant and Petroleum Refining Piping
   c. ASME B31.9 – Building Services Piping

3. American Water Works Association
   a. AWWA C-606 – Grooved and Shouldered Joints

D. Quality Assurance

1. To assure uniformity and compatibility of piping components in grooved end piping systems, all grooved products utilized shall be supplied by Victaulic. Grooving tools shall be supplied by the same manufacturer as the grooved components.

2.01 Materials:

A. Pipe/Grooved (Standard/Lightwall): Carbon Steel, A-53B/A-106B - Roll or cut grooved-ends as appropriate to pipe material, wall thickness, pressures, size and method of joining. Pipe ends to be grooved in accordance with Victaulic current listed standards conforming to ANSI/AWWA C-606.

B. Victaulic Mechanical Couplings for Joining Carbon Steel Pipe

1. Victaulic Standard Mechanical Couplings, 2 inch (DN50) through 12 inch (DN300): Manufactured in two segments of cast ductile iron, conforming to ASTM A-536, Grade 65-45-12. Gaskets shall be pressure-responsive synthetic rubber, grade to suit the intended service, conforming to ASTM D-2000. (Gaskets used for potable water applications shall be UL classified in accordance with ANSI/NSF-61 for potable water service.) Mechanical Coupling bolts shall be zinc plated (ASTM B-633) heat treated carbon steel track head conforming to ASTM A-449 and ASTM A-183, minimum tensile strength 110,000 psi (758450 kPa) as provided standard Victaulic.

a. Rigid Type: Coupling housings with offsetting, angle-pattern bolt pads shall be used to provide system rigidity and support and hanging in accordance with ANSI B31.1, B31.9, and NFPA 13.
   a. 2” (DN50) through 8” (DN200): Victaulic Style 107H (Quick-Vic™). Installation ready rigid coupling for direct stab installation without field disassembly. Gasket shall be Grade “EHP” EPDM compound with red color code designed for operating temperatures from -30 deg F (-34 deg C) to +250 deg F (+120 deg C).
   b. 10” (DN250) through 12” (DN300): Victaulic Style 07 (Zero-Flex®). Standard rigid coupling. Gasket shall be Grade “E” EPDM compound with green color code designed for operating temperatures from -30 deg F (-34 deg C) to +230 deg F (+110 deg C).

b. Flexible Type: Use in locations where vibration attenuation and stress relief are required. Flexible couplings may be used in lieu of flexible connectors at equipment connections. Three couplings, for each connector, shall be placed in close proximity to the vibration source.
   a. 2” (DN50) through 8” (DN0200): Victaulic Style 177 (Quick-Vic™). Installation ready flexible coupling for direct stab installation without field disassembly. Gasket shall be Grade “EHP” EPDM compound with red color code designed for operating temperatures from -30 deg F (-34 deg C) to +250 deg F (+120 deg C).
   b. 10” (DN250) through 12” (DN300): Victaulic Style 75 or 77 standard flexible couplings. Gasket shall be Grade “E” EPDM compound with green color code designed for operating temperatures from -30 deg F (-34 deg C) to +230 deg F (+110 deg C).

2. Flange Adapters: For use with grooved end pipe and fittings, flat faced, for mating to ANSI Class 125 / 150 flanges. Victaulic Style 741. For direct connection to ANSI Class 300 flanges use Victaulic Style 743.

3. Grooved couplings shall meet the requirements of ASTM F-1476.

4. Gasket: Synthetic rubber conforming to steel pipe outside diameter and coupling housing, manufactured of elastomers as designated in ASTM D-2000.

   a. Reference shall always be made to the latest published Selection Guide for Victaulic Gaskets for proper gasket selection for the intended service.

5. Victaulic AGS Mechanical Couplings, 14 inch (DN350) through 60 inch (DN1500): Couplings shall consist of two ASTM A-536 ductile iron housing segments, a wide elastomer pressure responsive gasket, and zinc electroplated carbon steel track head bolts and nuts conforming to the physical and chemical requirements of ASTM A-449 and the physical requirements of ASTM A-183.

   a. Coupling housings designed with the wedge-shaped AGS key profile to engage the mating pipe(s)/component(s) wedge-shaped AGS grooves. Housings include lead-in chamfer to accommodate a wider acceptable range of initial pipe positions. Housings shall be coated with orange enamel or galvanized.

   b. Gasket: Wide width, pressure-responsive, synthetic rubber of a FlushSeal® design, conforming to steel pipe outside diameter and coupling housing, manufactured of elastomers as designated in ASTM D-2000.

      1) Grade “E” EPDM with green color code designed for operating temperatures from -30 deg F (-34 deg C) to +230 deg F (+110 deg C).
      2) Grade “T” Nitrile with orange color code designed for operating temperatures from -20 deg F (-29 deg C) to +180 deg F (+82 deg C).
      3) Grade “L” Silicone with red color code designed for operating temperatures of -30 deg F (-34 deg C) to +350 deg F (+177 deg C); recommended for dry heat service (air without hydrocarbons).
      4) Reference shall always be made to the latest published Selection Guide for Victaulic Gaskets for proper gasket selection for the intended service.

   c. Coupling Types:

      1) Victaulic W07 AGS Rigid Coupling: Coupling key shall be designed to fill the wedge shaped AGS groove to provide a rigid joint that corresponds with support spacings as defined by ASME B31.1 and B31.9. Systems incorporating rigid couplings require the calculated thermal growth/contraction of the piping

system to be fully compensated for in the design of the piping system through use of adequate flexible components.

2) Victaulic W77 AGS Flexible Coupling: Coupling key shall be designed to fit into the wedge shaped AGS groove and allow for linear and angular movement, vibration attenuation, and stress relief. Support requirements defined by Victaulic Design Data Submittal 26.01.

3) Victaulic Style W741 Flange Adapter 14 inch (DN350) to 24 inch (DN600): For use with AGS grooved end pipe and fittings, flat faced, for mating to ANSI Class 125 / 150 flanges.

C. Victaulic Grooved End Fittings:

1. Standard fittings shall be cast of ductile iron conforming to ASTM A-536, Grade 65-45-12, forged steel conforming to ASTM A-234, Grade WPB 0.375" wall (9,53 mm wall), or fabricated from Std. Wt. Carbon Steel pipe conforming to ASTM A-53, Type F, E or S, Grade B. Fittings provided with an alkyd enamel finish or hot dip galvanized to ASTM A-153. Zinc electroplated fittings and couplings conform to ASTM B633.

a. Internal Plastic Coatings: Fittings to be provided with internal and applicable external (sealing surfaces) coating, (i.e. Corvel 1660) and inspected to ensure holiday free surfaces where media may interact with fitting substrate (as defined above). Fittings to be supplied with end caps to prevent chipping of surface coating.

2. AGS Fittings shall be supplied with factory AGS grooved ends, for use with Victaulic W07 or W77 couplings and W741 flange adapter. Fittings shall be manufactured of ductile iron conforming to ASTM A-536, forged carbon steel conforming to ASTM A-234, or factory fabricated from carbon steel pipe conforming to ASTM A-53. Fittings shall be manufactured to the dimensional standards ASME B16.9. Orange enamel coated or galvanized.

3. Victaulic Hole-Cut Branch Outlets:

a. Bolted Branch Outlet: Branch reductions on 2"(DN50) through 8"(DN200) header piping. Bolted branch outlets shall be manufactured from ductile iron conforming to ASTM A-536, Grade 65-45-12, with synthetic rubber gasket, and heat treated carbon steel zinc plated bolts and nuts conforming to physical properties of ASTM A-183. Victaulic Style 920 / 920N.

b. Strapless Outlet: 1/2"(DN15) or 3/4"(DN20) NPT outlet on 4" (DN100) and larger header sizes rated for 300 PSI (2065 kPa). Victaulic Style 923.

c. Strapless Thermometer Outlet: To accommodate industrial glass bulb thermometers with standard 1-1/4"-18 NEF 2B extra fine thread and 6" (152mm) nominal bulb length on 4" (DN100) and larger header sizes rated for 300 PSI (2065 kPa).

D. Victaulic Grooved End Valves

1. Butterfly Valves

a. 2"(DN50) through 12"(DN300) Sizes: 300 psi CWP (2065 kPa) suitable for bidirectional and dead-end service at full rated pressure. Body shall be grooved end black enamel coated ductile iron conforming to ASTM A536. Disc shall be [electroless nickel plated ductile iron] [stainless steel] [aluminum bronze] with blowout proof 416 stainless steel stem. Disc shall be offset from the stem centerline to allow full 360 degree seating. Seat shall be pressure responsive [EPDM] [Lubricated Nitrile] [Fluoroelastomer]. Valve bearings shall be TFE lined fiberglass, and stem seals shall be of the same grade elastomer as the valve seat. Valve shall be complete with ISO flange for actuation mounting. Valve operators shall be lever handle or gear operator, available with memory stop feature, locking device, chainwheel, or supplied bare. (Valve with EPDM seat is UL classified in accordance with ANSI/NSF-61.) Victaulic Vic®-300 MasterSeal™.

b. 14” (DN350) through 24” (DN600) Sizes: 300 psi (2065 kPa), AGS grooved ends, polyphenylene sulfide (PPS) coated ductile iron body (ASTM A-536, Grade 65-45-12), PPS coated ductile iron disc (ASTM A-536), and two piece 17-4 PH S/S stem design. Seat and seal material to suit intended service. Reinforced PTFE bearings and gear operator. Bubble tight, dead-end, or bi-directional service. With memory stop for throttling, metering or balancing service. Victaulic Vic®-300 AGS.

Note: Refer to latest published Victaulic literature, Butterfly Valve Material Selection section, for liner/seat and disc material recommendations for chemical service.

2. Check Valves:

a. 2"(DN50) through 3"(DN80) Sizes Spring Assisted: Black enamel coated ductile iron body, ASTM A-536, Grade 65-45-12, stainless steel non-slam tilting disc, stainless steel spring and brass shaft, nickel-plated seat surface, 365 psi (2517 kPa). Victaulic Series 716H.
b. 4”(DN100) through 12”(DN300) Sizes Spring Assisted: Black enamel coated ductile iron body, ASTM A-536, Grade 65-45-12, elastomer encapsulated ductile iron disc suitable for intended service, stainless steel spring and shaft, welded-in nickel seat, 300 psi (2065 kPa). Victaulic Series 716.
c. 2”(DN50) through 4”(DN100) Sizes Horizontal Swing: Horizontal installation, ductile iron body, ASTM A-536, Grade 65-45-12, and Type 316 stainless steel clapper. Synthetic rubber bumper & bonnet seals suitable for intended service, stainless steel wetted parts, 300 psi (2065 kPa). Victaulic Series 712.
d. 4”(DN100) through 12”(DN300) Sizes Venturi Check: Black enamel coated ductile iron body, ASTM A-536, Grade 65-45-12 with venturi-like taps, elastomer encapsulated ductile iron disc suitable for intended service, stainless steel spring and shaft, welded-in nickel seat, 300 psi (2065 kPa). Victaulic Series 779.

e. 14” (DN350) through 24” (DN600) Check Valves: 230 psi (1585 kPa), AGS grooved ends, spring-assisted dual disc check valve. ASTM A-536, Grade 65-45-12 coated ductile iron body, EPDM seat bonded to the valve body, 304 stainless steel disc, and 300 series stainless steel spring and shaft. Victaulic Series W715.

3. Tri-Service Valve Assembly: Combination shut-off, throttling and non-slam check valve.

   a. 2-1/2”(DN65) through 12”(DN300) Sizes: Vic®-300 MasterSeal™ butterfly valve with memory stop feature assembled with Series 716 (2-1/2” & 3”)(DN65 & DN75) or Style 779 Venturi Check (4” – 12”)(DN100-DN300). Series 779 check valve with venturi like taps for flow measurement. Working pressures to 300 psi (2065 kPa).
   b. 14” (DN350) through 24” (DN600) Sizes: Victaulic AGS-Vic300 butterfly valve with gear operator and memory stop feature assembled with Series W715 Check Valve. Working pressures to 232 psi (1600 kPa).

4. Ball Valves: 1-1/2”(DN40) through 6”(DN150) sizes, ASTM A-536, Grade 65-45-12, ductile iron body, chrome plated carbon steel ball and stem, TFE seats, with Fluoroelastomer seals. 800 psi (5515 kPa). Victaulic Series 726.

5. Plug Valves: 3"(DN75) through 12"(DN300) sizes, with memory stop for throttling, metering or balancing service. Unidirectional bubble-tight shut-off, bi-directional sealing optional. ductile iron body, bonnet, and plug, ASTM A-536, Grade 65-45-12. Plug encapsulated with synthetic rubber suitable for intended service. Welded-in nickel seat, stainless steel self-lubricating bearings. 175 PSI (1200 kPa). AWWA rigid groove dimensions may be adapted to IPS sized system through the use of Victaulic Style 307 transition couplings. Victaulic Series 377 eccentric plug balancing valves.

6. Circuit Balancing Valves:

   a. 2”(DN50) and Smaller Sizes: 300 psi (2065 kPa), y-pattern, globe type with soldered or threaded ends, non-ferrous Ametal® brass copper alloy body, EPDM o-ring seals. 4-turn digital readout handwheel for balancing, hidden memory feature with locking tamper-proof setting, and connections for portable differential meter. Victaulic / TA Hydronics Series 786 or 787 STAD.
      1. Install Series 78U union port fitting and Series 78Y strainer/ball valve combination to complete terminal hookup at coil outlet.
      2. Install Series 793 differential pressure controller to stabilize differential pressure and ensure stable and accurate modulating control. Ametal® brass copper alloy body, bonnet, cone and spindles, threaded ends only.

   b. 2-1/2”(DN65) and Larger Sizes: 300 psi (2065 kPa), y-pattern, globe type with flanged or grooved ends, ASTM A536 ductile iron body, all other metal parts of Ametal® brass copper alloy, EPDM O-ring seals. 8, 12 or 16-turn digital readout handwheel for balancing, hidden memory feature with locking

tamper-proof setting, and connections for portable differential meter. Victaulic / TA Hydronics Series 788 or 789 STAG.

c. Series 739 / 794 Differential Pressure Controller: For use in conjunction with TA Balancing valves to stabilize differential pressure and ensure stable and accurate modulating control. Ductile iron or Ametal body, Ametal® brass copper alloy bonnet, cone, and spindles, flanged ends only.

E. Victaulic Grooved End Specialties

1. Expansion Joints:

a. 2”(DN50) through 6”(DN150) Sizes: Packless, gasketed, type with grooved end telescoping body, suitable for axial end movement to 3”. 350 psi (2410 kPa). Victaulic Style 150 Mover®.
b. 3/4"(DN20) and Larger Sizes: Expansion joint consisting of a series of grooved end nipples joined with flexible-type couplings. Joint movement and expansion capabilities determined by number of couplings / nipples used in the joint. Victaulic Style 155.

2. Dielectric Waterways: 1”(DN25) through 8”(DN200) sizes, grooved, plain end, or threaded end, ASTM A-53 carbon steel or ASTM A-536 ductile iron body, zinc electroplated, with LTHS high temperature stabilized polyolefin polymer liner. Victaulic Style 47.

3. Strainers - Grooved-End

a. T-Type Strainer. 2” (DN50) through 12”(DN300) sizes, 300 PSI (2065 kPa) T-Type Strainer shall consist of ductile iron (ASTM A-536, Grade 65-45-12) body, Type 304 stainless steel frame and mesh removable basket with No. 12 mesh, 2"-3" (DN50-DN75) strainer sizes, or No. 6 mesh, 4"-12" (DN100-DN300) strainer sizes, 57% free open area. Victaulic Style 730.
b. T-Type Strainer: 14” (DN350) through 24” (DN600) sizes, 300 PSI (2065 kPa), AGS grooved end “Tee” strainer. Factory fabricated carbon steel body conforming to ASTM A-53, Grade B, carbon steel T-bolt hinged closure/cap, and type 304 stainless steel frame and mesh basket, (6x6 mesh for 14”(DN350) and 16”(DN400) sizes, and 4x4 mesh for 18”(DN450) through 24”(DN600) sizes). Victaulic Series W730.
c. Y-Type Strainer. 2”(DN50) through 18”(DN450) sizes, 300 PSI (2065 kPa) Y-Type Strainer shall consist of ductile iron body, ASTM A-536, Grade 65-45-12, Type 304 stainless steel perforated metal removable baskets with 1/16" (1,6mm) diameter perforations 2"-3" (DN50-DN75) strainer sizes, 1/8" (3,2mm) diameter perforations 4"-12" (DN100-DN300) strainer sizes, and 0.156” (4mm) diameter perforations 14” -18” (DN350-DN450) strainer sizes. Victaulic Style 732 and W732.

4. Suction Diffuser – Flanged outlet with grooved inlet connections, rated to 300 psi (2065 kPa). Ductile iron (ASTM A-536) body, 304 stainless steel frame and perforated sheet diffuser with 5/32" (4,0mm) diameter holes. Removable 20

mesh 304 stainless steel start-up pre-filter, outlets for pressure/temperature drain connections, and base support boss. Victaulic Series 731-G and W731-G.

F. Victaulic Tooling:

1. Tools shall be manufactured and supplied by Victaulic. Use roll sets or cut groovers compatible with the pipe material and wall thickness per Victaulic installation instructions (I-100).

2. Common wedge shaped AGS groove for pipe sizes 14" (DN350) through 24"(DN600) requiring one (1) common AGS roll set per tool, for use with approved Victaulic grooving tools. (VE414MC, VE416 FSD, VE424 MC, or VE436.)

3.01 Execution:

A. Installation:

1. Pipe ends shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove for proper gasket sealing.

2. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified.

3. Install the Victaulic AGS piping system in accordance with the latest Victaulic installation instructions.

4. AGS products shall not be installed with standard grooved end pipe or components. (Installing AGS products in combination with standard grooved end products could result in joint separation and/or leakage.)

5. Use Victaulic grooving tools with AGS roll sets to groove the pipe. Follow Victaulic guidelines for tool selection and operation.

6. Couplings installation shall be complete when visual metal-to-metal contact is reached.

7. See the latest copy of Victaulic's Field Assembly and Installation Instruction Pocket Handbook (I-100).

B. Training:

1. A Victaulic factory trained representative (direct employee) shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and product installation.

C. Application:

1. A Victaulic representative shall periodically visit the job site and review installation. Contractor shall remove and replace any improperly installed products.

2. Victaulic grooved mechanical pipe couplings, fittings, valves and other grooved components may be used as an option to welding, threading or flanged methods.

3. All grooved components shall conform to local code approval and/or as listed by ANSI-B-31.1, B-31.3, B-31.9, ASME, UL/ULC, FM, IAPMO or BOCA.

4. Grooved end product manufacturer to be ISO-9001 certified.

END OF SECTION

SPECIFICATION REVISION INDEX

Revision No.	Revision Date	Issued for	Signatures				
			Prepared By	Reviewed By	Project Engineer	Project Manager	Client
A	11/28/2016	60% Submittal	CMF	JG	JG	STD	
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SECTION 15060

SUPPORTS AND ANCHORS

PART 1 GENERAL

1.01 SUMMARY:

A. Section Includes: Extent of supports and anchors required by this Section is indicated on Drawings and/or specified in other Division 15 Sections.

B. Types of supports and anchors include the following:
   1. Horizontal piping hangers and supports.
   2. Vertical piping clamps.
   3. Hanger rod attachments.
   4. Building attachments.
   5. Saddles and shields.
   6. Spring hangers and supports.
   7. Miscellaneous materials.
   8. Anchors.
   9. Equipment supports.

C. Supports and anchors furnished as part of factory-fabricated equipment are specified as part of equipment assembly in other Division 15 Sections.

1.02 SUBMITTALS:

A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
   1. Manufacturer's assembly type Shop Drawings for each type of support and anchor, indicating dimensions, weights, required clearances, and methods of assembly of components.
   2. Submit manufacturer's technical product data, including installation instructions, for each type of support and anchor.

B. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01730 Operation and Maintenance Data for items included under this Section. Include maintenance data and parts list for each type of support and anchor.

1.03 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of supports and anchors, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards:
   1. Comply with applicable plumbing codes pertaining to product materials and installation of supports and anchors.

C. Manufacturers Standardization Society of the Valves and Fittings Industry, Inc. (MSS) Standard Compliance:
   1. Provide pipe hangers and supports of which materials, design, and manufacture comply with MSS SP-58.
   2. Select and apply pipe hangers and supports complying with MSS SP-69.
   3. Fabricate and install pipe hangers and supports complying with MSS SP-89.
   4. Terminology used in this Section is defined in MSS SP-90.

PART 2 PRODUCTS

2.01 MANUFACTURERS:

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
   1. Hangers and Supports:
      a. B-Line Systems, Inc.
      b. Carpenter and Patterson, Inc.
      c. Corner & Lada Co., Inc.
      d. Anvil International. Elcen Metal Products Co.
      e. Fee & Mason Mfg. Co., Div. Figgie International.

   2. Saddles and Shields:
      a. Elcen Metal Products Co.
      b. Pipe Shields, Inc.

2.02 MATERIALS:

A. Hangers, supports, and anchors shall be 316 stainless steel within the containment area and below the eleveation of the containment berm. All others may be galvanized steel, galvanized malleable iron, or galvanized wrought iron unless otherwise noted on the Drawings

2.03 HORIZONTAL PIPING HANGERS AND SUPPORTS:

A. Except as otherwise indicated, provide factory-fabricated horizontal piping hangers and supports complying with MSS SP-58, of one of the following MSS types listed, selected by General Contractor to suit horizontal piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hangers and supports to exactly fit pipe size for bare piping, and to exactly fit around piping insulation with saddle or shield for insulated piping. Provide copper-plated hangers and supports for copper piping systems.
   1. Adjustable Steel Clevis Hangers: MSS Type 1.
   2. Pipe Hangers: MSS Type 5.
   3. Adjustable Band Hangers: MSS Type 9.
   4. Adjustable Roller Hangers: MSS Type 43.
   5. Pipe Roll Stands: MSS Type 44.
   6. Pipe Rolls and Plates: MSS Type 45.
   7. Adjustable Pipe Roll Stands: MSS Type 46.

2.04 VERTICAL PIPING CLAMPS:

A. Except as otherwise indicated, provide factory fabricated vertical piping clamps complying with MSS SP-58, of one of the following types listed, selected by General Contractor to suit vertical piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Select size of vertical piping clamps to exactly fit pipe size of bare pipe. Provide copper-plated clamps for copper piping systems.
   1. Two-Bolt Riser Clamps: MSS Type 8.

B. Where Thermal expansion movement is required on vertical risers, riser clamps shall be provided with a sleeve and a spacer between the riser clamps to allow for pipe movement. Sleeves shall be attached to the CPVC piping to prevent friction between pipe and hanger.

2.05 HANGER-ROD ATTACHMENTS:

A. Except as otherwise indicated, provide factory-fabricated hanger-rod attachments complying with MSS SP-58, of one of the following MSS types listed, selected by General Contractor to suit horizontal piping hangers and building attachments, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hanger-rod attachments to suit hanger rods. Provide copper-plated hanger-rod attachments for copper piping systems.
   1. Steel Turnbuckles: MSS Type 13.
   2. Malleable Iron Sockets: MSS Type 16.
   3. Steel Weldless Eye Nuts: MSS Type 17.

2.06 BUILDING ATTACHMENTS:

A. Except as otherwise indicated, provide factory-fabricated building attachments complying with MSS SP-58, of one of the following MSS types listed, selected by General Contractor to suit building substrate conditions in accordance with MSS SP-69 and manufacturer's published product information. Select size of building attachments to suit hanger rods. Provide copper-plated building attachments for copper piping systems.
   1. Concrete Inserts: MSS Type 18. Inserts for concrete shall be galvanized steel, 316 stainless steel or galvanized malleable iron. Inserts shall be 316 stainless steel for all applications in wastewater treatment and water treatment process areas unless otherwise noted on drawings.
   2. Top Beam Clamps: MSS Type 25.
   3. Steel Brackets:
      a. Side Beam Brackets: MSS Type 34.

2.07 SADDLES AND SHIELDS:

A. Except as otherwise indicated, provide saddles or shields under piping hangers and supports, factory fabricated, for all insulated piping. Size saddles and shields for exact fit to mate with pipe insulation.

B. Protection Saddles: MSS Type 39; fill interior voids with segments of insulation matching adjoining insulation.
C. Protection Shields: MSS Type 40, of length recommended by manufacturer to prevent crushing of insulation.

D. Thermal Hanger Shields: Constructed of 360-degree insert of high density, 100 psi, waterproof calcium silicate, encased in 360-degree sheet metal shield. Provide assembly of same thickness as adjoining insulation.

2.08 SPRING HANGERS AND SUPPORTS:

A. Except as otherwise indicated, provide factory-fabricated spring hangers and supports complying with MSS SP-58, of one of the following MSS types listed, selected by General Contractor to suit piping systems in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select spring hangers and supports to suit pipe size and loading.
   1. Restraint Control Devices: MSS Type 47.
   2. Spring Cushion Hangers: MSS Type 48.

2.09 MISCELLANEOUS MATERIALS:

A. All metals within the containment area that is below the elevation of the berm shall be 316 stainless steel unless otherwised noted on the Drawings.

B. Metal Framing: Provide products complying with NEMA Standard ML 1.

C. Steel Plates, Shapes, and Bars: Provide products complying with ANSI/ASTM A 36.

D. Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix at a ratio of 1 part cement to 3 parts sand, by volume, with minimum amount of water required for placement and hydration.

E. Heavy-Duty Steel Trapezes: Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS standards.

F. Pipe Guides: Provide factory-fabricated guides, of cast semi-steel or heavy fabricated steel, consisting of bolted 2-section outer cylinder and base with 2-section guiding spider bolted tight to pipe. Size guide and spiders to clear pipe and insulation (if any) and cylinder. Provide guides of length recommended by manufacturer to allow indicated travel.

G. Roof Support Base/Supports on Liner Systems: Blocks shall be made of rubber with channel through the center for water drainage. Blocks shall be designed to accept formed strut products such as B-Line and Unistrut. Anchoring bolts for the support system shall not impact the mounting surface. The system shall be designed with no sharp edges and shall be compatible with roofing system and/or liner material. All hardware shall be 316 stainless steel. Product shall be EATON DURA-BLOK system or equal.

PART 3 EXECUTION

3.01 INSPECTION:

A. Examine areas and conditions under which supports and anchors are to be installed. Do not proceed with Work until unsatisfactory conditions have been corrected in manner acceptable to General Contractor .

3.02 PREPARATION:

A. Proceed with installation of hangers, supports, and anchors only after required building structural work has been completed in areas where the Work is to be installed. Correct inadequacies including (but not limited to) proper placement of inserts, anchors, and other building structural attachments.

B. Prior to installation of hangers, supports, anchors, and associated Work, General Contractor shall meet at Site with Engineer, installer of each component of associated Work, inspection and testing agency representatives (if any), installers of other work requiring coordination with Work of this Section, and Engineer for purpose of reviewing material selections and procedures to be followed in performing the Work in compliance with requirements specified.

3.03 INSTALLATION OF BUILDING ATTACHMENTS:

A. Install building attachments at required locations within concrete or on structural steel for proper piping support. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional building attachments where support is required for additional 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 securely to forms. Where concrete with compressive strength less than 2,500 psi is indicated, install reinforcing bars through openings at top of inserts.

3.04 INSTALLATION OF HANGERS AND SUPPORTS:

A. Install hangers, supports, clamps, and attachments to support piping properly from building structure; comply with MSS SP-69. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Install supports with maximum spacings complying with MSS SP-69. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping.

B. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.

C. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper-plated or by other recognized industry methods.

D. Provisions for Movement:
   1. Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
   2. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
   3. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ANSI B31.1 Pressure Piping Codes are not exceeded.

E. 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 ANSI B31.1.
   2. Shields: Where low compressive strength insulation or vapor barriers are indicated on cold or chilled water piping, install coated protective shields. For pipe 8-inch and over, install wood insulation saddles.
   3. Saddles: Where insulation without vapor barrier is indicated, install protection saddles.

3.05 INSTALLATION OF ANCHORS:

A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ANSI B31.1, and to prevent transfer of loading and stresses to connected equipment.

B. Fabricate and install anchor by welding steel shapes, plates and bars to piping and to structure. Comply with ANSI B31.1 and with AWS standards.

C. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions, to limit movement of piping and forces to maximums recommended by manufacturer for each unit.

D. Where not otherwise indicated, install anchors at ends of principal pipe-runs, at intermediate points in pipe runs between expansion loops and bends. Make provisions for pre-set of anchors as required to accommodate both expansion and contraction of piping.

3.06 EQUIPMENT SUPPORTS:

A. Furnish to General Contractor, scaled layouts of all required bases, with dimensions of bases, and location to column centerlines. Furnish templates, anchor bolts, and accessories necessary for base construction.

B. Provide structural steel stands to support equipment not floor mounted or hung from structure. Construct of structural steel members or steel pipe and fittings. Provide factory-fabricated tank saddles for tanks mounted on steel stands.

3.07 ADJUSTING AND CLEANING:

A. Adjust hangers so as to distribute loads equally on attachments.

B. Provide grout under supports so as to bring piping and equipment to proper level and elevations.

C. Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION

SPECIFICATION REVISION INDEX

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SECTION 15070

IDENTIFICATION FOR PROCESS PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Nameplates.
   2. Tags.
   3. Stencils.
   4. Pipe markers.
   5. Ceiling tacks.
   6. Labels.
   7. Lockout devices.

1.2 SUBMITTALS

A. Product Data: Submit manufacturer's catalog literature for each product required.

B. Shop Drawings: Submit list of wording, symbols, letter size, and color-coding for mechanical identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

C. Samples: Submit [two] <_____> [tags] [labels] [pipe markers] [and] <_____> for each size used on Project.

D. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.

E. Manufacturer's Certificate: Certify that [products] <_____> meet or exceed [specified requirements] <_____>.

F. Qualifications Statement:
   1. Submit qualifications for manufacturer.

1.3 SUSTAINABLE DESIGN SUBMITTALS

A. Product Cost Data: Verify compliance with Project sustainable design requirements. Exclude cost of labor and equipment to install products.
   1. Provide cost data for following products:
      a. Salvaged, refurbished, and reused products.
      b. Products with recycled material content.
      c. Regional products.
      d. <_____>.

1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of tagged valves; include valve tag numbers.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Materials: Furnish [two] <_____> [containers of spray-on adhesive] <_____>.

1.6 QUALITY ASSURANCE

A. Conform to ASME A13.1 for color scheme for identification of piping systems and accessories.

B. Perform Work according to <_____> standards.

C. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum [three] <_____> years' [documented] experience.

PART 2 PRODUCTS

2.1 NAMEPLATES

A. Manufacturers:
   1. <Click link above to find, evaluate, and insert list of manufacturers from SpecAgent>.
   2. Substitutions: [Permitted] [Not permitted].
   3. Furnish materials according to <_____> standards.

B. Description: Laminated three-layer plastic with engraved [black] <_____> letters on light, contrasting background color.

2.2 TAGS

A. Plastic Tags:
   1. Manufacturers:
      a. <Click link above to find, evaluate, and insert list of manufacturers from SpecAgent>.
      b. Substitutions: [Permitted] [Not permitted].
   2. Description:
      a. Laminated three-layer plastic with engraved [black] <_____> letters on light, contrasting background color.
      b. Minimum Tag Size and Configuration: <_____> inches (<_____> mm); [diameter] [square] <_____>.

B. Metal Tags:
   1. Manufacturers:
      a. <Click link above to find, evaluate, and insert list of manufacturers from SpecAgent>.
      b. Substitutions: [Permitted] [Not permitted].
   2. Description:
      a. [Brass] [Aluminum] [Stainless-steel] <_____> construction; stamped letters.

b. Minimum Tag Size and Configuration: <_____> inches (<_____> mm); [diameter] [square] <_____> with finished edges.

C. Information Tags:
1. Manufacturers:
a. <Click link above to find, evaluate, and insert list of manufacturers from SpecAgent>.
b. Substitutions: [Permitted] [Not permitted].
2. Description:
a. Clear plastic with printed [DANGER] [CAUTION] [WARNING] <_____> and message.
b. Minimum Tag Size: <_____> by <_____> inch (<_____> by <_____> mm).
c. Furnish grommet and self-locking nylon ties.
3. Tag Chart: Typewritten, letter-size list of applied tags and location, [in anodized aluminum frame] [plastic laminated].

2.3 STENCILS

A. Manufacturers:
1. <Click link above to find, evaluate, and insert list of manufacturers from SpecAgent>.
2. Substitutions: [Permitted] [Not permitted].
3. Furnish materials according to <_____> standards.

B. Description:
1. Clean-cut symbols.
2. Letters:
a. Up to <_____>-inch (<_____>-mm) Outside Diameter of Insulation or Pipe: <_____>-inch (<_____>-mm)-high letters.
b. <____>- to <____>-inch (<____>- to <____>-mm) Outside Diameter of Insulation or Pipe: <_____>-inch (<_____>-mm)-high letters.
c. Over <_____>-inch (<_____>-mm) Outside Diameter of Insulation or Pipe: <_____>-inch (<_____>-mm)-high letters.

C. Stencil Paint: As specified in Section 09 90 00 - Painting and Coating ; semigloss enamel.

D. Color-Coding and Lettering Size: Conform to ASME A13.1.

2.4 PIPE MARKERS

A. Color-Coding and Lettering Size: Conform to ASME A13.1.

B. Plastic Pipe Markers:
1. Manufacturers:
a. <Click link above to find, evaluate, and insert list of manufacturers from SpecAgent>.
b. Substitutions: [Permitted] [Not permitted].
2. Description:
a. Factory-fabricated, flexible, semirigid plastic.
b. Preformed to fit around pipe or pipe covering.
c. Larger sizes may have maximum sheet size with spring fastener.

C. Plastic Tape Pipe Markers:
   1. Manufacturers:
      a. <Click link above to find, evaluate, and insert list of manufacturers from SpecAgent>.
      b. Substitutions: [Permitted] [Not permitted].
   2. Description: Flexible, vinyl film tape with pressure-sensitive adhesive backing and printed markings.

D. Plastic Underground Pipe Markers:
   1. Manufacturers:
      a. <Click link above to find, evaluate, and insert list of manufacturers from SpecAgent>.
      b. Substitutions: [Permitted] [Not permitted].
   2. Description:
      a. Brightly colored, continuously printed plastic ribbon tape.
      b. Minimum <_____> inches (<_____> mm) wide by <_____> mil (<_____> mm) thick.
      c. Manufactured for direct burial service.

2.5 CEILING TACKS

A. Manufacturers:
   1. <Click link above to find, evaluate, and insert list of manufacturers from SpecAgent>.
   2. Substitutions: [Permitted] [Not permitted].
   3. Furnish materials according to <_____> standards.

B. Description:
   1. Steel construction.
   2. Head: <_____>-inch (<_____>-mm) diameter; color-coded.

C. Color-Coding and Lettering Size: Conform to ASME A13.1.

2.6 LABELS

A. Manufacturers:
   1. <Click link above to find, evaluate, and insert list of manufacturers from SpecAgent>.
   2. Substitutions: [Permitted] [Not permitted].
   3. Furnish materials according to <_____> standards.

B. Description:
   1. [Aluminum] [Polyester] [Laminated Mylar] <_____> construction.
   2. Minimum Size: <_____> by <_____> inches (<_____> by <_____> mm).
   3. Adhesive backed, with printed identification [and bar code].

2.7 LOCKOUT DEVICES

A. Lockout Hasps:
   1. Manufacturers:
      a. <Click link above to find, evaluate, and insert list of manufacturers from SpecAgent>.
      b. Substitutions: [Permitted] [Not permitted].
   2. Description:

a. [Anodized aluminum] [Reinforced nylon] <_____> construction.
b. Furnish hasp with erasable label surface.
c. Minimum Size: <_____> by <_____> inches (<_____> by <_____> mm).

B. Valve Lockout Devices:
1. Manufacturers:
a. <Click link above to find, evaluate, and insert list of manufacturers from SpecAgent>.
b. Substitutions: [Permitted] [Not permitted].
2. Description:
a. [Nylon] [Steel] [Plastic] <_____> construction.
b. Furnish device preventing access to valve operator and accepting lock shackle.

2.8 SUSTAINABILITY CHARACTERISTICS

A. Material and Resource Characteristics:
1. Recycled Content Materials: Furnish materials with maximum available recycled content [including:] [.]
a. <_____>.
2. Regional Materials: Furnish materials extracted, processed, and manufactured within 500 miles (800 km) of Project site [including:] [.]
a. <_____>.

PART 3 EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Prepare surfaces as specified in Section 09 90 00 - Painting and Coating for stencil painting.

3.2 INSTALLATION

A. Apply stencil painting as specified in Section 09 90 00 - Painting and Coating.

B. Install identifying devices after completion of coverings and painting.

C. Install plastic nameplates with corrosion-resistant mechanical fasteners or adhesive.

D. Labels:
1. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer.
2. For unfinished covering, apply paint primer before applying labels.

E. Tags:
1. Install tags using corrosion-resistant chain.
2. Number tags [consecutively by location] [as indicated in tag schedule].

F. Install underground plastic pipe markers <____> to <____> inches (<____> to <____> mm) below finished grade, directly above buried pipe.

G. Identify valves in main and branch piping with tags.

H. Piping:
   1. Identify piping, concealed or exposed, with [plastic pipe markers] [plastic tape pipe markers] [stenciled painting].
   2. [Use tags on piping <_____>-inch (<_____>-mm) diameter and smaller.]
   3. Identify service, flow direction, and pressure.
   4. Install in clear view and align with axis of piping.
   5. Locate identification not to exceed <_____> feet (<_____> m) on straight runs, including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.

I. Ceiling Tacks:
   1. Provide ceiling tacks to locate valves above T-bar-type panel ceilings.
   2. Locate in corner of ceiling panel closest to equipment.

3.3 ATTACHMENTS

A. Schedules: <_____>.

B. Tables: <_____>.

C. Illustrations: <_____>.

D. Forms: <_____>.

END OF SECTION

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SECTION 15075

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 RELATED DOCUMENTS:

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

1.02 SUMMARY:

A. Section Includes:

1. Equipment labels.
2. Pipe labels.
3. Valve tags.

1.03 SUBMITTALS:

A. Product Data: For each type of product indicated.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve numbering scheme.

E. Valve Schedules: For each piping system to include in maintenance manuals.

1.04 COORDINATION:

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 PRODUCTS

2.01 EQUIPMENT LABELS:

A. Metal Labels for Equipment:

1. Material and Thickness: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
4. Fasteners: Stainless-steel rivets or self-tapping screws.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

2.02 PIPE LABELS:

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pre-tensioned Pipe Labels: Pre-coiled, semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches high.

2.03 VALVE TAGS:

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire-link or beaded chain; or S-hook.

PART 3 EXECUTION

3.01 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulates.

3.02 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.03 PIPE LABEL INSTALLATION

A. Piping Color-Coding: Painting of piping is specified in Section 09900 – Painting.

B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

C. Pipe Label Color Schedule:

1. Domestic Cold Water Piping:

    a. Background Color: Blue.
    b. Letter Color: White.

3.04 VALVE TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape:

   a. Cold Water: 1-1/2 inches, round.

2. Valve-Tag Color:

   a. Cold Water: Blue.

3. Letter Color:

   a. Cold Water: White.

END OF SECTION

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SPECIFICATION REVISION INDEX

Revision No.	Revision Date	Issued for	Signatures				
			Prepared By	Reviewed By	Project Engineer	Project Manager	Client
A	11/28/2016	60% Submittal	CMF	JG	JG	STD	
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SECTION 15080

MECHANICAL INSULATION

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes: Labor, materials, tools, equipment, accessories, and services necessary for providing and installing mechanical insulation of all items as shown on Drawings and/or specified herein. All sizing required for preparation of painting shall be performed under this Section.

1.02 QUALITY ASSURANCE

A. Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics, and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 (NFPA 255) method.
   1. Exception: Outdoor mechanical insulation may have flame spread index of 75 and smoke developed index of 150.
   2. Exception: Industrial mechanical insulation that will not affect life safety egress of building may have flame spread index of 75 and smoke developed index of 150.

1.03 SUBMITTALS

A. Shop Drawings: Submit in accordance with requirements of Section 01330, Shop Drawings covering the items included under this Section.

B. General Contractor shall furnish Engineer for approval a list of insulating materials and thickness for items listed on Schedule. The list shall be complete including all types and thicknesses of insulation used for the various services as well as the limits of Work.

C. Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, k-value, thickness, and furnished accessories for each mechanical system requiring insulation.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver insulation, coverings, cements, adhesives, and coatings to Site in containers with manufacturer's stamp or label, affixed showing fire hazard indexes of products.

B. Protect insulation against dirt, water, and chemical and mechanical damage. Do not install damaged or wet insulation; remove from Site.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of mechanical insulation products, of types and sizes required, whose products have been in satisfactory use in similar service for not less than three years.

B. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
   1. Type I Insulation:
      a. CSG.
      b. Manville - Micro-lok 650.
      c. Owens/Corning Fiberglass.
      d. UpJohn Company.

2.02 MATERIALS

A. Insulation for each of the applications listed on Schedule shall be one of the following types:
   1. Type I Insulation shall be a precision molded pipe covering composed of bonded fiberglass wool resin, minimum density 7.25 pcf, or polyurethane or phenolic foam minimum density 1.8 pcf formed in two half cylinders.
      a. Indoor insulation cover shall be the all service jacket ASJ type with integral vapor barrier unless otherwise noted on Schedule, and outdoor insulation cover shall be 0.016-inch aluminum jacket.
      b. All ASJ jacket laps and butt joint strips shall be of the adhesive contact type. Aluminum jackets shall have mastic laps and butt joints and banded using soft aluminum bands on 12-inch centers.
      c. Fittings and valve insulation shall be fabricated from mitered segments of pipe insulation or molded fitting covers. Fitting and valve insulation shall be coated with insulating cement, dried, coated with a vapor barrier mastic and, on indoor applications, wrapped with fiberglass reinforcing cloth and a second coat of mastic applied or, on outdoor applications, coated with a method recommended by the manufacturer and approved by Engineer.

2.03 FIELD-APPLIED JACKETS

A. Aluminum Jacket: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005, Temper H-14.
   1. Sheet and roll stock ready for shop or field sizing.
   2. Finish and thickness: Smooth Finish, 0.016 Thickness.
   3. Moisture Barrier for Indoor Applications: 3-mil thick, heat-bonded polyethylene and kraft paper.
   4. Moisture Barrier for Outdoor Applications: 3-mil thick, heat-bonded polyethylene and kraft paper.
   5. Factory-Fabricated Fitting Covers:
      a. Same material, finish, and thickness as jacket.
      b. Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
      c. Tee covers.
      d. Flange and union covers.
      e. End caps.
      f. Beveled collars.
      g. Valve covers.
      h. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.04 INSULATING CEMENT

A. Insulating cement shall be mineral fiber ASTM Standard and designed for use on hot or cold surfaces from temperature ranges of 0 to 1200 degrees F.

PART 3 - EXECUTION

3.01 ACCEPTABLE INSTALLERS

A. Installer's Qualifications: Firm with at least three years successful installation experience on projects with mechanical insulations similar to that required for this Project.

3.02 INSPECTION

A. Examine areas and conditions under which mechanical insulation is to be installed. Do not proceed with Work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.03 INSTALLATION

A. The Mechanical Insulation Schedule gives the application, type, temperature, and thickness of insulation required. This Schedule should be used with the following interpretations.
   1. Insulation thickness selection not shown on Schedule shall be based on the ASHRAE Standard for the conditions of 80 degrees F ambient air temperature with 80 percent relative humidity indoor, and 0 degrees F ambient air temperature with 90 percent relative humidity outdoor, with operating temperatures as listed on Schedule.
   2. Type I insulation thickness shown on Schedule is based on fiberglass with a k-factor (thermal conductivity Btu/hour/square foot/degree F inch) of 0.255 at 40 degrees F. Insulation thickness

may be increased or decreased in direct proportion to the k-factor of the insulation material furnished.

3. Heating equipment items shall have an insulation thickness to limit surface temperature to 140 degrees F.

3.04 PLUMBING PIPING SYSTEM INSULATION

A. Omit insulation on chrome-plated exposed piping (except for handicapped fixtures), air chambers, unions, strainers, check valves, balance cocks, flow regulators, drain lines from water coolers, drainage piping located in crawl spaces or tunnels, buried piping, fire protection piping, and pre-insulated equipment.

B. Cold Piping:
   1. Application Requirements: Insulate the following cold plumbing piping systems:
      a. Stabilized Lake Mead Water cold water piping less than 2-1/2” diameter.

C. Hot Piping / Tepid Water:
   1. Application Requirements: Insulate the following hot plumbing piping systems:
      a. Stablized Lake Mead Water hot water piping.
      b. Lake Mead Stabilized Water hot water recirculating piping.
      c. Tepid water piping.
      d. Tepid water recirculating piping.

3.05 INSTALLATION OF PIPING INSULATION

A. Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.

B. Install insulation on pipe systems subsequent to installation of heat tracing, painting, testing, and acceptance of tests.

C. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with single cut piece to complete run. Do not use cut pieces or scraps abutting each other.

D. Clean and dry pipe surfaces prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.

E. Maintain integrity of vapor-barrier jackets on pipe insulation, and protect to prevent puncture or other damage.

F. Exposed covering shall be cleaned and sized for painting.

G. Premolded sectional covers shall be applied to flanges, fittings, and valves where possible. All other flanges, fittings, and valves shall be field-insulated and jacket applied manually. Insulation shall be the same thickness as that of the pipe.

H. In general, pipe hangers will be sized to fit the pipe with insulation placed over the pipe hanger assembly (except hot water or steam piping where hangers are sized to fit the insulation with a

saddle). Insulation shall be grooved for hangers. The hanger area shall be completely filled with insulating material and sealed in vapor barrier areas.

I. Insulation, where terminated at equipment connections, ends of pipe, etc., shall be tapered at a 45-degree angle and sealed.

J. Extend piping insulation without interruption through walls, floors, and similar piping penetrations, except where otherwise indicated.

K. Butt pipe insulation against pipe hanger insulation inserts. For hot pipes, apply 3-inch-wide vapor barrier tape or band over the butt joints. For cold piping apply wet coat of vapor barrier lap cement on butt joints and seal joints with 3-inch-wide vapor barrier tape or band.

3.10 EXISTING INSULATION REPAIR

A. Repair damaged sections of existing mechanical insulation, either previously damaged or damaged during this construction period. Replacement insulation shall be of same thickness as existing insulation. Jacket of replacement insulation shall overlap and seal to the existing insulation.

3.11 PROTECTION AND REPLACEMENT

A. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.

B. Insulation installer shall advise General Contractor of required protection for insulation work during remainder of construction period to avoid damage and deterioration.

MECHANICAL INSULATION SCHEDULE

Application	Type	Temp.(°F)	Duct/Pipe Size Minimum Insulation Thickness Interior < 2-1/2"	Interior >2-1/2"	Exterior < 2-1/2"	Exterior 2-1/2"-4"		Remarks
PLUMBING								
Cold Water	I	55	1-	-	1	-	-	All except ground-buried. Provide Aluminum jacket on exterior piping.
Hot Water/Tempered Hot Water/Tepid	I	60-100	1	-	1	-	-	Provide Aluminum jacket on exterior piping.

END OF SECTION

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SPECIFICATION REVISION INDEX

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SECTION 15085

PIPING INSULATION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Process piping insulation.
   2. Jacketing.
   3. Accessories.

1.2 SUBMITTALS

A. Product Data: Product description, thermal characteristics, list of materials, and thickness for each service and location.

B. Samples: Submit [two] <_____> samples of representative size, illustrating each insulation type.

C. Manufacturer's Certificate: Certify that [products] <_____> meet or exceed [specified requirements] <_____>.

D. Manufacturer's Instructions: Submit manufacturer's published literature indicating recommended installation procedures.

E. Qualifications Statements:
   1. Submit qualifications for manufacturer and applicator.
   2. Submit manufacturer's approval of applicator.

1.3 QUALITY ASSURANCE

A. Test pipe insulation for maximum flame-spread index of 25 and maximum smoke-developed index not exceeding [50] [450], according to ASTM E84.

B. ASTM C585 for inner and outer diameters of pipe insulation.

C. Factory-fabricated fitting covers according to ASTM C450.

D. Perform Work according to <_____> standards.

E. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum [three] <_____> years' [documented] experience.

F. Applicator: Company specializing in performing Work of this Section with minimum [three] <_____> years' [documented] experience [and approved by manufacturer].

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store insulation according to manufacturer's instructions.

B. Protect insulation from weather and construction traffic, dirt, water, chemicals, and damage by storing in original wrapping.

1.5 AMBIENT CONDITIONS

A. Install insulation only when ambient temperature and humidity conditions are within ranges as recommended by manufacturer.

B. Maintain recommended temperature and humidity before, during, and after installation for minimum of [24] <_____> hours.

1.6 EXISTING CONDITIONS

A. Field Measurements:
   1. Verify field measurements prior to fabrication.
   2. Indicate field measurements on Shop Drawings.

1.7 WARRANTY

A. Furnish [five] <_____>-year manufacturer's warranty for human-made fiber.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Glass Fiber and Mineral Fiber Insulation:
   1. Manufacturers:
      a. <Click link above to find, evaluate, and insert list of manufacturers from SpecAgent>.
      b. Substitutions: [Permitted] [Not permitted].

B. Closed-Cell Elastomeric Insulation:
   1. Manufacturers:
      a. <Click link above to find, evaluate, and insert list of manufacturers from SpecAgent>.
      b. Substitutions: [Permitted] [Not permitted].

C. Polyisocyanurate Foam Insulation:
   1. Manufacturers:
      a. <Click link above to find, evaluate, and insert list of manufacturers from SpecAgent>.
      b. Substitutions: [Permitted] [Not permitted].

D. Extruded Polystyrene Insulation:
   1. Manufacturers:
      a. <Click link above to find, evaluate, and insert list of manufacturers from SpecAgent>.
      b. Substitutions: [Permitted] [Not permitted].

****** [OR] ******

E. Furnish materials according to <_____> standards.

2.2 PIPE INSULATION

A. Type P-1:
   1. Description: Molded glass fiber.
   2. ASTM C547[; ASTM C795 for application on austenitic stainless steel].
   3. Thermal Conductivity: <_____> Btu-in./h-ft.-deg F at 75 degrees F (<_____> W/m-deg C at <_____> degrees C).
   4. Operating Temperature Range: <_____> to <_____> degrees F (<_____> to <_____> degrees C).
   5. Vapor Barrier Jacket:
      a. Description: Factory-applied, reinforced foil kraft with self-sealing adhesive joints.
      b. ASTM C1136, Type I.
   6. Jacket Temperature Limits: <_____> to <_____> degrees F (<_____> to <_____> degrees C).

B. Type P-2:
   1. Description: Molded glass fiber.
   2. ASTM C547[; ASTM C795 for application on austenitic stainless steel].
   3. Thermal Conductivity: <_____> Btu-in./h-ft.-deg F at 75 degrees F (<_____> W/m-deg C at <_____> degrees C).
   4. Operating Temperature Range: <_____> to <_____> degrees F (<_____> to <_____> degrees C).

C. Type P-3:
   1. Description:
      a. Semi-rigid, fibrous glass board.
      b. Noncombustible.
      c. End grain adhered to jacket.
   2. ASTM C612[; ASTM C795 for application on austenitic stainless steel].
   3. Thermal Conductivity: <_____> Btu-in./h-ft.-deg F at 75 degrees F (<_____> W/m-deg C at <_____> degrees C).
   4. Operating Temperature Range: <_____> to <_____> degrees F (<_____> to <_____> degrees C).
   5. Vapor Barrier Jacket:
      a. Description: Factory-applied, reinforced foil kraft with self-sealing adhesive joints.
      b. ASTM C1136, Type I.
   6. Jacket Temperature Limits: <_____> to <_____> degrees F (<_____> to <_____> degrees C).

D. Type P-4:
   1. Description:
      a. Semi-rigid, fibrous glass board.
      b. Noncombustible.
   2. ASTM C612[; ASTM C795 for application on austenitic stainless steel].

3. Thermal Conductivity: <_____> Btu-in./h-ft.-deg F at 75 degrees F (<_____> W/m-deg C at <_____> degrees C).
4. Operating Temperature Range: <_____> to <_____> degrees F (<_____> to <_____> degrees C).

E. Type P-5:
1. Description:
   a. Flexible, closed-cell elastomeric.
   b. Tubular.
2. ASTM C534 (C534M), Type I.
3. Thermal Conductivity: <_____> Btu-in./h-ft.-deg F at 75 degrees F (<_____> W/m-deg C at <_____> degrees C).
4. Operating Temperature Range: <_____> to <_____> degrees F (<_____> to <_____> degrees C).

F. Type P-6:
1. Description:
   a. Flexible, closed-cell elastomeric.
   b. Tubular.
2. ASTM C534 (C534M), Type I.
3. Thermal Conductivity: <_____> Btu-in./h-ft.-deg F at 75 degrees F (<_____> W/m-deg C at <_____> degrees C).
4. Maximum Service Temperature: <_____> degrees F (<_____> degrees C).
5. Operating Temperature Range: <_____> to <_____> degrees F (<_____> to <_____> degrees C).

G. Type P-7:
1. Description:
   a. Flexible, nonhalogen, closed-cell elastomeric.
   b. Tubular.
2. ASTM C534 (C534M), Type I.
3. Thermal Conductivity: 0.27 Btu-in./h-ft.-degree F at 75 degrees F (0.039 W/m-deg C at 24 degrees C).
4. Maximum Service Temperature: 250 degrees F (120 degrees C).
5. Operating Temperature Range: <_____> to <_____> degrees F (<_____> to <_____> degrees C).

H. Type P-8:
1. Description:
   a. Preformed mineral fiber.
   b. Noncombustible.
2. ASTM C547, Type I or II.
3. Thermal Conductivity: <_____> Btu-in./h-ft.-deg F at 75 degrees F (<_____> W/m-deg C at <_____> degrees C).
4. Maximum Service Temperature: <_____> degrees F (<_____> degrees C).
5. Canvas Jacket:
   a. Description: Plain-weave cotton fabric treated with fire-retardant lagging adhesive.
   b. UL listed.
   c. Weight: <_____> oz./sq. yd (<_____> g/sq m).

I. Type P-9:
   1. Description: Polyisocyanurate foam insulation, formed into shapes for use as pipe insulation.
   2. ASTM C591, Type IV.
   3. Density: <_____> pcf (<_____> kg/cu m).
   4. Thermal Conductivity: 180-day aged value of <_____> Btu-in./h-ft.-deg F at 75 degrees F (<_____> W/m-deg C at <_____> degrees C).
   5. Operating Temperature Range: <_____> to <_____> degrees F (<_____> to <_____> degrees C).
   6. Vapor Barrier Jacket:
      a. ASTM C1136, Type I.
      b. Factory-Applied Film Thickness: <_____> mils (<_____> mm).
      c. Water Vapor Permeance: <_____> perms.

J. Type P-10:
   1. Description: Extruded polystyrene insulation, formed into shapes for use as pipe insulation.
   2. ASTM C578, Type XIII.
   3. Thermal Conductivity: 180-day aged value of <_____> Btu-in./h-ft.-deg F at 75 degrees F (<_____> W/m-deg C at <_____> degrees C).
   4. Operating Temperature Range: <_____> to <_____> degrees F (<_____> to <_____> degrees C).
   5. Vapor Barrier Jacket:
      a. ASTM C1136, Type I.
      b. Factory-Applied Film Thickness: <_____> mils (<_____> mm).
      c. Water Vapor Permeance: <_____> perms.

K. Type P-11:
   1. Description:
      a. Hydrous calcium silicate.
      b. Rigid molded.
      c. Color: White.
      d. Asbestos free.
   2. ASTM C533, Type I.
   3. Thermal Conductivity: <_____> Btu-in./h-ft.-deg F at 75 degrees F (<_____> W/m-deg C at <_____> degrees C).
   4. Operating Temperature Range: <_____> to <_____> degrees F (<_____> to <_____> degrees C).

2.3 PIPE INSULATION JACKETS

A. Vapor-Retarder Jacket:
   1. Description: White kraft paper with glass-fiber yarn, bonded to aluminized film.
   2. [ASTM C921.]
   3. Water Vapor Permeance:
      a. ASTM E96 (E96M).
      b. <_____> perms (<_____> ng/Pa/s/m).

B. PVC Plastic Pipe Jacket:
   1. Description:
      a. One-piece, molded-type fitting covers and sheet material.

b. Color: Off-white.
2. [ASTM D1785.]
3. Thickness: <_____> mils (<_____> mm).
4. Connections: [Brush-on welding adhesive] [Tacks] [Pressure-sensitive, color-matching vinyl tape].

C. Acrylonitrile Butadiene Styrene (ABS) Plastic Pipe Jacket:
1. Description:
a. One-piece, molded-type fitting covers and sheet material.
b. Color: Off-white.
2. Minimum Service Temperature: <_____> degrees F (<_____> degrees C).
3. Maximum Service Temperature: <_____> degrees F (<_____> degrees C).
4. Water Vapor Permeance:
a. ASTM E96 (E96M).
b. <_____> perms (<_____> ng/Pa/s/m).
5. Thickness: <_____> mils (<_____> mm).
6. Connection: Brush-on welding adhesive.

D. Aluminum Pipe Jacket:
1. [ASTM B209 (B209M).]
2. Sheet Thickness: <_____> inch (<_____> mm).
3. Finish: [Smooth] [Embossed] <_____>.
4. Joining: Longitudinal slip joints with laps.
5. Fitting Covers:
a. Description: Die-shaped, with factory-attached protective liner.
b. Thickness: <_____> inch (<_____> mm).
6. Metal Jacket Bands:
a. Width: <_____> inch (<_____> mm).
b. Thickness and Material: <_____> inch (<_____> mm), aluminum.

****** [OR] ******

c. Thickness and Material: <_____> inch (<_____> mm), stainless steel.

E. Stainless-Steel Pipe Jacket:
1. [ASTM A240 (A240M)] [or] [ASTM A666].
2. Material: Type [302] [304] [316] stainless steel.
3. Thickness: <_____> inch (<_____> mm).
4. Finish: [Smooth] [Corrugated].
5. Metal Jacket Bands:
a. Width: <_____> inch (<_____> mm).
b. Thickness and Material: <_____> inch (<_____> mm), stainless steel.

F. Field-Applied Glass-Fiber-Fabric Jacketing System:
1. Insulating cement/mastic.
2. Description: Hydraulic setting on mineral wool.
3. ASTM C195.
4. Glass-Fiber Fabric:
a. Cloth:

1) Untreated.
2) Weight: <_____> oz./sq. yd (<_____> g/sq m).

b. Blanket Density: <_____> lb./cu. ft (<_____> kg/cu m).

c. Weave: [5 by 5] [10 by 10] [10 by 20].

5. Indoor Vapor-Retarder Finish:

a. Description:

1) Type: Vinyl emulsion, acrylic.
2) Compatible with insulation.
3) Color: [Black] [White] <_____>.

b. Cloth:

1) Untreated.
2) Weight: <_____> oz./sq. yd (<_____> g/sq m).

2.4 PIPE INSULATION ACCESSORIES

A. Vapor-Retarder Lap Adhesive: Compatible with insulation.

B. Covering Adhesive Mastic: Compatible with insulation.

C. Piping 1-1/2-Inch (40-mm) Diameter and Smaller:
1. Description: Galvanized-steel insulation protection shield.
2. MSS SP-69, Type 40.
3. Length: Based on pipe size and insulation thickness.

D. Piping 2-Inch (50-mm) Diameter and Larger:
1. Description: Wood insulation saddle, hard maple.
2. Inserts Length: Not less than <_____> inches (<_____> mm).
3. Thickness and Contour: Match adjoining insulation.

E. Closed-Cell Elastomeric Insulation Pipe Hangers:
1. Description: Polyurethane insert with [aluminum] [stainless-steel jacket] single-piece construction and self-adhesive closure.
2. Thickness: Match pipe insulation.

F. Tie Wire: <_____>-inch (<_____>-mm) stainless steel with twisted ends on maximum <_____>-inch (<_____>-mm) centers.

G. Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement: ASTM C449.

H. Insulating Cement:
1. ASTM C195.
2. Hydraulic setting on mineral wool.

I. Adhesives: Compatible with insulation.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that [piping] [and] [equipment] has been tested before applying insulation materials.

B. Verify that surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION - PIPING SYSTEMS

A. Piping Exposed to View in Finished Spaces: Locate insulation and cover seams in least visible locations.

B. Fire-Rated Penetrations:
   1. Continue insulation through penetrations of building assemblies or portions of assemblies having fire-resistance rating of one hour or less.
   2. Provide intumescent firestopping when continuing insulation through assembly.
   3. Finish at supports, protrusions, and interruptions.
   4. Refer to Section 40 05 13 - Common Work Results for Process Piping for penetrations of assemblies with fire-resistance rating greater than one hour.

C. Piping Systems Conveying Fluids below Ambient Temperature:
   1. Insulate entire system, including fittings, valves, unions, flanges, strainers, flexible connections, [pump bodies,] and expansion joints.
   2. Jacketing:
      a. Furnish factory-applied or field-applied vapor-retarder jackets.
      b. Secure factory-applied jackets with pressure-sensitive adhesive with self-sealing longitudinal laps and butt strips.
      c. Secure field-applied jackets with outward-clinch expanding staples, and seal stapled penetrations with vapor-retarder mastic.
   3. Fittings, Joints, and Valves:
      a. Insulate with molded insulation of like material and thickness as adjacent pipe.
      b. Finish with glass cloth and vapor-retarder adhesive or PVC fitting covers.

D. Glass-Fiber Board Insulation:
   1. Apply insulation close to equipment by grooving, scoring, and beveling insulation.
   2. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
   3. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface; on cold equipment, use vapor-retarder cement.
   4. Cover wire mesh or bands with cement to a thickness to remove surface irregularities.

E. [Polyisocyanurate Foam Insulation] [Extruded Polystyrene Insulation]:
   1. Wrap elbows and fitting with vapor-retarder tape.
   2. Seal butt joints with vapor-retarder tape.

F. Hot Piping Systems Less than <_____> Degrees F (<_____> Degrees C):
   1. Furnish factory-applied or field-applied standard jackets, securing with outward-clinch expanding staples or pressure-sensitive adhesive system on standard factory-applied jacket and butt strips, or both.

2. Fittings, Joints, and Valves:
    a. Insulate with like material and thickness as adjoining pipe.
    b. Finish with glass cloth and adhesive or PVC fitting covers.
3. Do not insulate unions and flanges at equipment; bevel and seal ends of insulation at such locations.

G. Hot Piping Systems Greater than <_____> Degrees F (<_____> Degrees C):
1. Furnish factory-applied or field-applied standard jackets, securing with outward-clinch expanding staples or pressure-sensitive adhesive system on standard factory-applied jacket and butt strips, or both.
2. Fittings, Joints, and Valves:
    a. Insulate with like material and thickness as adjoining pipe.
    b. Finish with glass cloth and adhesive or PVC fitting covers.
3. Insulate flanges and unions at equipment.

H. Inserts and Shields:
1. Piping <_____>-Inch (<_____>-mm) Diameter and Smaller: Install [galvanized-]steel shield between pipe hanger and insulation.
2. Piping <_____>-Inch (<_____>-mm) Diameter and Larger:
    a. Install insert between support shield and piping, and under finish jacket.
    b. Insert Configuration: Minimum <_____> inches (<_____> mm) long, of thickness and contour matching adjoining insulation; may be factory fabricated.
    c. Insert Material: Compression-resistant insulating material suitable for planned temperature range and service.
3. Piping Supported by Roller-Type Pipe Hangers: Install [galvanized-]steel shield between roller and inserts.

I. Closed-Cell Elastomeric Insulation:
1. Miter joints at elbows.
2. Seal seams and butt joints with manufacturer's recommended adhesive.
3. If application requires multiple layers, apply with staggered joints.
4. Insulate fittings and valves with insulation of like material and thickness as adjacent pipe.

J. High-Temperature Pipe Insulation:
1. Install in multiple layers to meet scheduled thickness.
2. Attach each layer with bands, securing first layer with bands before installing next layer.
3. Stagger joints between layers.
4. Finish with canvas jacket [sized for finish painting].

****** [OR] ******

5. Cover with [aluminum jacket] [stainless-steel jacket] with seams located on bottom side of horizontal piping.

K. Piping Exposed in Equipment Rooms or Finished Spaces: Finish with [canvas jacket sized for finish painting] [PVC jacket and fitting covers] [ABS jacket and fitting covers] [aluminum jacket] [stainless-steel jacket].

L. Piping Exterior to Building:

1. [Provide vapor-retarder jacket.]
2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass-mesh-reinforced, vapor-retarder cement.
3. Cover with [aluminum] [stainless-steel] jacket with seams located at 3- or 9-o'clock position on side of horizontal piping, with overlap facing down to shed water, or on bottom side of horizontal piping.

M. Buried Piping:
1. Insulate only where insulation manufacturer recommends insulation product may be installed in trench or tunnel, or direct buried.
2. Install factory-fabricated assembly with inner all-purpose service jacket, with self-sealing lap, and asphalt-impregnated open-mesh glass fabric with aluminum foil sandwiched between three layers of bituminous compound.
3. Face outer surface with polyester film.

N. Heat-Traced Piping Interior to Building:
1. Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe.
2. Size large enough to enclose pipe and heat tracing.

O. Heat-Traced Piping Exterior to Building:
1. Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe.
2. Size insulation large enough to enclose pipe and heat tracing.
3. Cover with [aluminum] [stainless-steel] jacket with seams located at 3- or 9-o'clock position on side of horizontal piping, with overlap facing down to shed water.

P. Prepare pipe insulation for finish painting as specified in Section 09 90 00 - Painting and Coating.

3.3 ATTACHMENTS

A. Schedules: <_____>.

B. Tables: <_____>.

C. Illustrations: <_____>.

D. Forms: <_____>.

END OF SECTION

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SPECIFICATION REVISION INDEX

Revision No.	Revision Date	Issued for	Signatures				
			Prepared By	Reviewed By	Project Engineer	Project Manager	Client
A	11/28/2016	60% Submittal	CMF	JG	JG	STD	
B	2/15/2017	75% Submittal	CMF	JG	JG	STD	

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SECTION 15088

FLEXIBLE JOINTS AND COUPLINGS

PART 1 GENERAL

1.01 SCOPE OF WORK:

A. Furnish all labor, materials, equipment and incidentals required to completely install and put into service flexible couplings and expansion joints as specified herein and shown on the plans.

1.02 QUALITY ASSURANCE:

A. References:

1. AWWA 219 - Bolted, Sleeve-Type Couplings for Plain End Pipe ANSI/NSF Standard 61 - Drinking Water System Components

1.03 SUBMITTALS:

A. Submittals required after award of contract and prior to installation:

1. Technical bulletins and brochures on flexible couplings and expansion joints.

1.04 SHIPPING INSTRUCTIONS:

A. All parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed and the units and equipment are ready for operation.

B. All equipment and parts must be properly protected against any damage during a prolonged period at the site.

C. Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.

D. Storage and Protection: Take special care to prevent plastic and similar brittle items from being directly exposed to the sun, or exposed to extremes in temperature, preventing any deformation.

1.05 WARRANTY:

A. The equipment shall be warranted to be free from defects in workmanship, design and materials. If any part of the equipment should fail during the warranty period, it shall be replaced and the unit(s) restored to service at no expense to the Construction Manager. Warranty shall be for a period of two (2) years and begin on the Date of Final Acceptance.

PART 2 PRODUCTS

2.01 FLEXIBLE CONNECTOR/EXPANSION JOINT – DOUBLE SPHERE:

A. Flexible connectors shall be double sphere construction. All wetted parts shall be EPDM. Connectors shall provide the axial compression and elongation per table below.

Nominal Size	Axial Compression (inch)	Axial Elongation (inch)	Lateral Deflection (inch)
2”	2	1.125	1.75
2.5”	2	1.125	1.75
3”	2	1.375	1.75
4”	2	1.375	1.50
5”	2	1.375	1.50
6”	2	1.375	1.50
8”	2.375	1.375	1.375

Spring rate for material shall be 320 LBS/INCH or less

B. Bolted steel flanges shall meet or exceed the following design criteria:

1. Working pressure:

a. Minimum working pressure at 170 deg F of 225 PSI

2. Material: Galvanize Steel

C. Control rods, washers and bolts: (For applications where piping is not anchored and guided)

1. Indoors, outdoors aboveground, and in enclosed vaults and structures – Galvanized steel, ASTM A 193 grade B7 with ASTM A194, grade 2 H, heavy hex, nuts.

2. Buried and submerged – Type 316 stainless steel conforming to ASTM F593 bolts and ASTM F594 nuts.

D. Acceptable Manufacturers – METRAFLEX - DOUBLESPHERE

PART 3 EXECUTION

3.01 INSTALLATION:

A. All flexible couplings and expansion joints shall be installed in accordance with the instructions of the manufacturer and as shown on the plans.

3.02 INSPECTION AND TESTING

A. Hydrostatically test flexible pipe couplings, and joints, in place with the pipe being tested. Test in accordance with Sections 15044 – Pressure Testing of Piping, 15074 – Water Pipeline Testing as applicable or 15140 – Water Distribution Piping.

END OF SECTION

TETRA TECH	**Basic Plumbing Piping Materials and Methods** **Technical Specification**	**SPECIFICATION NUMBER: 15105** **PROJECT NUMBER: 117-7502016-L09** **PROJECT NAME: Weir Dewatering Treatment**

SPECIFICATION REVISION INDEX

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SECTION 15105

BASIC PLUMBING PIPING MATERIALS AND METHODS

PART 1 GENERAL

1.01 SUMMARY:

A. Section Includes: Piping materials and installation methods common to more than one Section of Division 15 and includes pipe, fitting and joining materials, piping specialties, and basic piping installation instructions.

1.02 SUBMITTALS:

A. Shop Drawings: Submit in accordance with Sections 01330, Shop Drawings and 15000, Mechanical General Requirements, covering the items included under this Section. Shop Drawing submittals shall include:
   1. Submit product data on the following items:
      a. Escutcheons.
      b. Dielectric Unions and Fittings.
      c. Mechanical Sleeve Seals.

B. Quality Control Submittals: Submit welders' certificates specified in Quality Assurance below.

1.03 QUALITY ASSURANCE:

A. Welder's Qualifications: All welders shall be qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.
   1. Welding procedures and testing shall comply with ANSI Standard B31.1.0, Standard Code for Pressure Piping, Power Piping, and The American Welding Society, Welding Handbook.

B. Soldering and Brazing procedures shall conform to ANSI B9.1 Standard Safety Code for Mechanical Refrigeration.

1.04 DELIVERY, STORAGE, AND HANDLING:

A. Provide factory-applied plastic end-caps on each length of pipe and tube except for concrete, corrugated metal, hub-and-spigot, and clay pipe. Maintain end-caps through shipping, storage, and handling to prevent pipe-end damage and prevent entrance of dirt, debris, and moisture.

B. Protect stored pipes and tubes. Elevate above grade and enclose with durable, waterproof wrapping. When stored inside, do not exceed structural capacity of the floor.

C. Protect flanges, fittings, and specialties from moisture and dirt by inside storage and enclosure, or by packaging with durable, waterproof wrapping.

D. Store pipe in a manner to prevent sagging and bending.

PART 2 PRODUCTS

2.01 MANUFACTURERS:

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
   1. Pipe Escutcheons:
      a. Chicago Specialty Mfg. Co.
      b. Grinnell.
      c. Sanitary-Dash Mfg. Co.
   2. Dielectric Unions:
      a. Eclipse, Inc.
      b. Perfection Corp.
      c. Watts Regulator Co.
   3. Mechanical Sleeve Seals:
      a. Thunderline Corp.
      b. Fab Pipe.
      c. Flexicraft.
      d. Or approved equal.
   4. High-Impact Thermoplastic Wall Sleeve:
      a. Thunderline.
      b. Flexicraft.
      c. Or approved equal.
   5. Steel Pipe (61.7) - Ground-Buried in Casing:
      a. RicWil Imperial Grade.
   6. Copper Tubing (63.3) - Pre-insulated Ground-Buried in Casing:
      a. Rovanco Insul-8.
      b. Ricwil Copper-Guard.
      c. Thermal Pipe Systems Coppercore Temptite.
   7. Rubber Hose (69.11):
      a. Uniroyal.
      b. BF Goodrich.

2.02 PIPE MATERIALS:

A. Refer to the individual piping system specification Sections in Division 15 for specifications on piping materials required from those listed from the following.

Steel Pipe (61.1)

Normal Service: Pressure to 150 psig
Temperature to 366 degrees F

	Size	Specifications
PIPE	1/4-inch through 4-inch	Carbon steel pipe, Schedule 40, ASTM A 53 seamless or electric welded.
	6-inch and larger	Carbon steel pipe, standard weight, ASTM A 53 seamless or electric welded. Note: Standard weight and Schedule 40 are the same in all sizes through 10 inches; in larger sizes, the wall thickness differs.
TYPE of JOINTS	1/4-inch through 2-inch	Screwed.
	2-1/2-inch and larger	Welded.
FITTINGS	1/4-inch through 2-inch	Black malleable iron, 150-pound class, screwed. ANSI standard B16.3.
	2-1/2-inch and larger	Carbon steel, standard weight, butt welding, ANSI Standard B16.9.
NIPPLES	1/4-inch through 2-inch	Carbon steel, extra strong, ASTM A 120 or A 53.
UNIONS	1/4-inch through 2-inch	Malleable iron, 250-pound class (500 WOG), railroad type with brass seats.
FLANGES	2-1/2-inch and larger	Carbon steel, 150-pound class, weld neck, standard raised face. ANSI standard B16.5. Exception: Face shall be flat when matching C.I. such as for mission check valves.
FLANGE GASKETS	2-1/2-inch and larger	1/16-inch Garlock Blue - Gard, Style 3200 (Style 3800 for natural gas), ring type. Exception: For flat-face flanges use face gaskets of same material as above.
THREAD SEALANT		Pipe dope. John Crane Insoluble Plastic Lead Seal No. 2, or approved equal. Exception: For temperatures in excess of 250 degrees F, use Teflon ribbon, 1/2-inch wide.

Steel Pipe (61.7)
(Ground-Buried in Casing)

Normal Service: Pressure to 150 psig
Temperature to 350 degrees F

Pipe: A 53, Grade B, Schedule 40, black steel with welded fittings.

Insulation: 1-1/2-inch-thick fiberglass.

Conduit: 10-gauge smooth wall steel with a minimum exterior coating of 20 mils of fiberglass-reinforced unmodified epoxy. Each layer of epoxy resin shall be oven cured to ensure complete cross-linking of the resins and to develop a holiday-free finish coating. Interior coating shall be a minimum of 6 mils thick epoxy resin.

Pipe Supports: Pipe shall be suitably spaced and supported in conduit by insulated support guides and shall permit the pipe to expand and/or contract freely without stress or wear on the pipe or insulation as well as provide for drainage and free air circulation.

Expansion Loops and Expansion Ells: Expansion loops shall be of proper design in accordance with stress limits indicated by ASME Code for pressure piping, District Heating Section: Expansion in pipe runs shall be taken up by expansion type elbows, joints, or loops. Loop piping shall be installed in conduit suitably sized to handle pipe movement.

Anchors: Prefabricated plate anchors shall consist of a steel plate, welded to pipe and conduit. The steel plate shall be 3/8-inch-thick for 6-5/8-inch to 10-3/4-inch conduit, 1/2-inch-thick for 12-3/4-inch to 22-inch conduit, and 3/4-inch-thick for conduit over 22-inch.

A concrete block shall be cast over the plate and conduit and shall be large enough for firm anchorage into undisturbed trench sidewalls and/or bottom. The concrete block shall be at least 30 inches in length and extend a minimum of 9 inches beyond the top and bottom of anchor plate.

Tests: Hot water piping shall be hydrostatically tested in the field under a pressure of 250 psig or twice the working, whichever is greater. All pipe joints shall be hammer tested.

Conduit shall be air tested in the field at 15 psig and all joints shall be soap tested. Air pressure shall be kept in the conduit until system is completed and turned over to Engineer. After conduit field joints have been soap tested, General Contractor shall apply protective coating over the conduit connectors, using materials supplied by manufacturer. The entire system, prior to backfill, shall be subjected to a final spark test of 5,000 volts, and any electrical leaks detected shall be repaired.

General Contractor shall furnish all necessary equipment and labor to perform the air test, including air compressor, gauges, conduit caps, temporary pipe and connections, etc., and complete the test to the satisfaction of ENGINEER. Manufacturer's field service instructor shall be present during critical periods of installation and test of the system. On completion of the installation, General Contractor shall deliver to Engineer, a certificate from the manufacturer stating that the installation has been made in accordance with manufacturer's recommendations.

Conduit connectors shall be welded type with minimum 10-gauge steel.

Terminal ends of conduits inside manholes, pits, or building walls shall be equipped with end seals consisting of a steel bulkhead plate welded to the pipe and conduit. Where there is no anchor within five feet of a terminal end, conduits shall be equipped with gland seals consisting of a packed stuffing box and gland follower mounted on a steel plate welded to end of conduit. End seals or gland seals shall be equipped with drain and vent openings located diametrically opposite on the vertical center line of the mounting plate and shall be shipped to Site with plugs in place. Terminate all conduits two inches beyond the inside face of manhole or building walls to protect any exposed piping insulation from damp-wall condensation.

To provide an effective moisture barrier, conduits shall be equipped with leakplates in building or manhole walls, but only when there is an anchor plate within five feet outside the wall. Leakplates shall consist of a steel plate flange four inches larger in outside diameter than the conduit, welded to the conduit only and located in the wall approximately six inches from the end of the conduit. Wall sleeves are recommended where leakplates are not furnished.

Steel Pipe (61.10)
(Galvanized)

Normal Service: Pressure to 150 psig
Temperature to 180 degrees F

	Size	Specifications
PIPE	1/4-inch through 4-inch	Galvanized steel pipe, Schedule 40, ASTM A 120 butt or electric welded.
	6-inch and larger	Galvanized steel pipe, standard weight, ASTM A 53 seamless or electric welded. Note: Standard weight and Schedule 40 are the same in all sizes through 10 inches; in larger sizes, the wall thickness differs.
TYPE OF JOINTS	1/4-inch through 4-inch 5-inch and larger	Screwed. Flanged.
FITTINGS	1/4-inch through 4-inch	Galvanized malleable iron, 150-pound class, screwed. ANSI Standard B16.3.
	5-inch and larger	Galvanized cast-iron, 125-pound class, flanged. ANSI Standard B16.1.
NIPPLES	1/4-inch through 4-inch	Galvanized steel, standard weight, ASTM A 120 or A 53.
UNIONS	1/4-inch through 2-inch	Galvanized malleable iron, 250-pound class, rail-road type, with brass seats.
FLANGES	2-1/2-inch and larger	Companion flanges, black cast iron, 125-pound class, screwed, flat-face. ANSI Standard B16.1.
GASKETS	2-1/2-inch and larger	1/16-inch Teflon, full-face type, or Durco "Taskline" Teflon.
THREAD SEALANT		Teflon tape.

Steel Pipe (61.11)
(Galvanized)

Maximum Pressure: 150 psig
Maximum Temperature: 200 degrees F

	Size	Specifications
PIPE	1/4-inch through 4-inch	Galvanized steel, Schedule 40, ASTM A 120 seamless or electric welded. Mill galvanized.
	6-inch and larger	Galvanized steel, standard weight, ASTM A 53 seamless or electric welded. Mill galvanized. Note: Standard weight and Schedule 40 are the same in all sizes through 10 inches; in larger sizes, the wall thickness differs.
TYPE OF JOINTS	1/4-inch through 2-inch	Screwed.
	2-1/2-inch and larger	Mechanical couplings.
FITTINGS	1/4-inch through 2-inch	Galvanized malleable iron, 150-pound class, screwed. ANSI Standard B16.3.
	2-1/2-inch and larger	Galvanized steel, grooved end for mechanical coupling. Gustin-Bacon, Victaulic.
NIPPLES	1/4-inch through 2-inch	Galvanized steel, standard weight, ASTM A 120 or A 53.
UNIONS	1/4-inch through 2-inch	Galvanized malleable iron, 250-pound class, rail-road type, with brass seats.
COUPLINGS	2-1/2-inch and larger	Malleable iron mechanical coupling with Grade M chlorinated butyl rubber gasket. Gustin-Bacon Series 100, Victaulic Style 77.
FLANGES	2-1/2-inch through 12-inch	Galvanized flanged adapter nipples, 125-pound flat-face. Gustin-Bacon No. 54, Victaulic Style 77.
	14-inch and larger	Companion flanges, black cast-iron, 125-pound class, screwed, flat-face. ANSI Standard B16.1
FLANGE GASKETS	2-1/2-inch and larger	1/16-inch Teflon, full-face type, or Durco "Taskline" Teflon.
THREAD SEALANT		Teflon tape.

Steel Pipe (61.12)
(Galvanized)

Normal Service: Pressure to 150 psig
Temperature to 180 degrees F

	Size	Specifications
PIPE	1/4-inch through 4-inch	Galvanized steel, Schedule 40, ASTM A 120 seamless or electric welded.
	6-inch and larger	Galvanized steel, standard weight, ASTM A 53 seamless or electric welded. Notes: 1. Standard weight and Schedule 40 are the same in all sizes through 10 inches; in larger sizes, the wall thickness differs. 2. To be mill galvanized having smooth appearance.
TYPE OF JOINTS	1/4-inch through 2 1/2-inch	Screwed.
	3-inch and larger	Mechanical couplings.
FITTINGS	1/4-inch through 2 1/2-inch	Galvanized malleable iron, 150-pound class, screwed. ANSI Standard B16.3.
	3-inch and larger	Galvanized steel, grooved end for mechanical coupling. Gustin-Bacon, Victaulic.
NIPPLES	1/4-inch through 3/4-inch	Galvanized steel, standard weight, ASTM A 120 or A 53.
UNIONS	1/4-inch through 3/4-inch	Galvanized malleable iron, 250-pound class, rail-road type, with brass seats.
COUPLINGS	1-inch and larger	Malleable iron mechanical coupling with flush-seal type chlorinated butyl rubber gasket. Gustin-Bacon Series 100 with Type II gasket, Victaulic Style 77 with Grade E gasket. Exception: Butyl rubber gasket is suitable for system supplied with oil-free air only. If air com-pressors are oil-lubricated type, use Buna-N flush-seal type gaskets.
FLANGES	1-inch through 12-inch	Galvanized flanged adapter nipples, 125-pound flat-face. Gustin-Bacon No. 54, Victaulic Style 77.
	14-inch and larger	Companion flanges, black cast-iron, 125-pound class, screwed, flat-face. ANSI Standard B16.1.
FLANGE GASKETS		1/16-inch Teflon, full-face type, or Durco "Taskline" Teflon.
THREAD SEALANT		Teflon tape.

Ductile Iron Pipe (62.5)

Normal Service: Pressure to approx. 250 psig
Temperature to 180 degrees F

	Size	Specifications
PIPE	3-inch and larger	Ductile Iron, ASTM 21.51 (AWWA C151) and ASTM A 536, Grade 60-45-10 Class 54 cement-lined interior, coal tar varnish coating - ground-buried universal rust-inhibitive primer exposed.
TYPE OF JOINTS	3-inch and larger	Push-on joint, compression with restrained mechanical joint fittings - ground-buried, flanged or grooved coupling - exposed.
FITTINGS	3-inch and larger	Ductile Iron, ASA 21.10, 250 psi rating.
GASKETS	3-inch and larger	1/16-inch rubber.
FLANGES (when required)	3-inch and larger	Ductile iron, ANSI 21.15 (AWWA C115) dimensions ANSI B16.1; threads ANSI B 2-1, bolts ASTM A 307, Grade B. All nuts and bolts to be cadmium-plated.

NOTE: Ground-buried pipe to be restrained for pressures up to 180 psi as noted in the pipe restraint schedule.

Copper Tubing (63.1)

Normal Service: Pressure to 150 psig
Temperature to 250 degrees F

NOTES: 1. Use solder fittings at all joints between terminal points.

2. Bends may be used for 1/4-inch and 3/8-inch tubing. Bends shall be made with a bending tool to the following minimum radii:

1/4-inch: 9/16-inch min. radius
3/8-inch: 15/16-inch min. radius

	Size	Specifications
PIPE	All sizes	Copper tubing, type L, hard-drawn above ground. Type K (soft) for below grade.
TYPE OF JOINTS	1/4-, 3/8-, 1/2-inch	Soldered or compression type as required. (see Note 1).
	5/8-inch and larger	Soldered. (Exposed.) Flared. (Buried.)
SOLDERED FITTINGS	All sizes	Wrought copper or cast bronze, solder-joint fittings. ANSI Standard B16.22.
COMPRESSION FITTINGS (EXPOSED)	1/4-, 3/8-, 1/2-inch	Brass compression type fittings. Gyrolok, Swagelok, Parker CPI.
UNIONS	1/4-inch through 2-inch	Wrought copper or cast bronze, solder joint union.
FLANGES	All sizes	Copper, solder-joint flange. 150-pound ASME drilling. Raised or flat face to match equipment.
GASKETS		1/16-inch Teflon; ring type for raised-face, or full-face for flat face flange.
SOLDER		Tin/Antimony (or lead-free to meet code requirements).
THREAD SEALANT (where necessary)		Teflon tape.

Copper Tubing (63.2)

Normal Service: Maximum Pressure: 150 psig
Maximum Temperature: 250 degrees F

NOTES: 1. System shall have all brazed joints except where accessory equipment requires screwed or flanged joints.

2. Oxygen systems require special treatment to ensure the complete absence of oil from all internal surfaces.

	Size	Specifications
PIPE	1/4-inch through 2-inch	Copper tubing, type L, hard-drawn. For refrigerant piping use seamless copper tubing, ASTM B 280, Type ACR.
TYPE OF JOINTS	1/4-inch through 2-inch	Brazed.
FITTINGS	1/4-inch through 2-inch	Wrought copper, solder-joint fittings. ANSI Standard B16.22.
UNIONS	1/4-inch through 2-inch	Wrought or cast copper, solder-joint union.
FLANGES (see Note 1)	1/4-inch through 2-inch	Copper, solder-joint flange. 150-pound ASME drilling. Raised or flat face to match equipment.
GASKETS		1/16-inch Garlock Blue - Gard, Style 3200; ring type for raised-face, or full-face for flat face flange. (Exception: Use Teflon for Co_2 and N_2)
BRAZING MATERIALS		AWS A5.8, Classification BAg-1 (Sil-fos).
THREAD SEALANT (where necessary)		Teflon tape.

PVC Pipe (64.1)

Normal Service: Maximum Pressure: 150 psig
Maximum Temperature: 150 degrees F

	Size	Specifications
PIPE	1/2-inch through 6-inch	PVC Type I, Schedule 80, ASTM D 1785.
TYPE OF JOINTS	1/2-inch through 6-inch	Solvent welded.
FITTINGS	1/2-inch through 6-inch	PVC, Schedule 80, socket type, ASTM D 2467.
FLANGES (where necessary)	1/2-inch through 6-inch	PVC, 150-pound, flat-face, Schedule 80, socket type.
GASKETS	1/2-inch through 6-inch	1/16-inch solid neoprene, full-face type.

NOTE: Provide 20-gauge (0.032-inch) aluminum jacket on all piping in return air plenums.

Sodium hypochlorite and sodium hydroxide piping joints shall be made with Oatey, Lo-Voc heavy-duty gray, Industrial Grade PVC cement. PVC cement shall be NSF listed and meet ASTM D 2564 and D 1412. Cement shall be resistant to caustics and hypochlorites up to 15 percent solution.

High Density Polyethylene Pipe (64.2)

Normal Service: Gas Distribution
Pressure to approx. 80 psig
Temperature to 140 degrees F

	Size	Specifications
PIPE	3/4-inch and larger	High-density polyethylene, SDR-11, ASTM D 2513, PE 3408.
TYPE OF JOINTS	3/4-inch and larger	Fusion welded, ASTM D 2513 or socket.
FITTINGS	3/4-inch and larger	High-density polyethylene, SDR-11, socket fusion type, with diameters compatible with pipe for fusion joining.
RISERS	All	Factory-assembled, certified to meet requirements of Category I of ASTM D 2513.
GASKETS	3/4-inch and larger	1/16-inch solid neoprene, full-face type.
FLANGES (when required)	3/4-inch and larger	PVC, 150-pound, flat-face, Schedule 80, socket type.
IDENTIFICATION	ALL	Natural Gas Piping shall be identified with yellow color or stripe and shall contain the words “GAS” and “ASTM D 2513”
ACCESSORIES	ALL	All underground nonmetallic piping shall be installed with a Tracer wire which conforms to International Fuel Gas Code.

PVC DWV Pipe (64.6)

Normal Service: Maximum Pressure: 5 psig
Maximum Temperature: 150 degrees F

	Size	Specifications
PIPE	1-inch through 8-inch	PVC, Schedule 40, ASTM D 2665.
TYPE OF JOINTS	1-inch through 8-inch	Solvent welded.
FITTINGS	1-inch through 8-inch	PVC, Schedule 40, socket type, ASTM D 2949.

Rubber Hose (69.11)

Normal Service: Pressure to approx. 50 psig
Temperature to 120 degrees F

	Size	Specifications
PIPE	1-1/2-inch through 8-inch	Acids discharge hose, 3/16-inch minimum wall thickness w/built-up ends.,
TYPE OF JOINTS	1-1/2-inch through 8-inch	Split flanges, compress hose ends.

2.03 JOINING MATERIALS:

A. Welding Materials: Comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials appropriate for the wall thickness and chemical analysis of the pipe being welded.

B. Brazing Materials: Comply with SFA-5.8, Section II, ASME Boiler and Pressure Vessel Code for brazing filler metal materials appropriate for the materials being joined.

C. Gaskets for Flanged Joints: Gasket material shall be full-faced for cast-iron flanges and raised-face for steel flanges. Select materials to suit the service of the piping system in which installed and which conform to their respective ANSI Standard (A21.11, B16.20, or B16.21). Provide materials that will not be detrimentally affected by the chemical and thermal conditions of the fluid being carried.

2.04 PIPING SPECIALTIES:

A. Escutcheons: Chrome-plated, stamped steel, hinged, split-ring escutcheon, with set screw. Inside diameter shall closely fit pipe outside diameter, or outside of pipe insulation where pipe is insulated. Outside diameter shall completely cover the opening in floors, walls, or ceilings.

B. Unions: Malleable-iron, Class 150 for low-pressure service and Class 250 for high-pressure service; hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends.

C. Dielectric Unions: Provide dielectric unions with appropriate end connections for the pipe materials in which installed (screwed, soldered, or flanged), which effectively isolate dissimilar metals, prevent galvanic action, and stop corrosion. Insulated and gasketed, galvanized, malleable iron unions as manufactured by Crane No. 1259, ITT - Grinnell Figure 470, or equal.

D. Sleeves: Unless otherwise shown on Drawings, at all points where pipes must pass through walls, floors or roofs of structures, General Contractor shall furnish and install suitable sleeves or wall castings meeting the requirements of Section 01600.
   1. In general, the wall sleeve or casting shall be of the same material as the pipe, or standard weight steel pipe thimbles of at least one size larger than the pipe itself shall be installed. Iron pipe wall castings, wall pipe, transition sleeves and solid sleeves shall meet the requirements or AWWA Specifications C100 and shall be of the lightest class conforming to the pressure rating of the pipelines which they connect, but in no case shall be lighter than Class B. All sleeves shall be shop-coated with universal primer 2 mils minimum thickness.
   2. A high-impact thermoplastic wall sleeve as manufactured by Thunderline, may be used for low and standard temperature service.

E. Sleeve Seals: Unless otherwise shown or permitted, the space between the pipe and the sleeve shall be caulked at the inside and outside wall faces on walls exposed to earth or water/sewage, at one face of the other walls, and at the top surface of floors and slabs. The space shall be caulked with lead and oakum as specified under Bell and Spigot Lead with an RTV-silicone rubber adhesive as manufactured by General Electric, or sealed with a rubber link seal. Rubber link seal shall be identical rubber links interconnected with bolts and elongated nuts and washers. The sealing element shall be made of synthetic rubber material especially compounded to resist aging, ozone, sunlight,

and chemical action. Bolts and metal parts shall be made of galvanized or cadmium-plated steel to resist corrosion. Rubber link seal joints shall be submitted to ENGINEER for approval.

PART 3 EXECUTION

3.01 PREPARATION:

A. Ream ends of pipes and tubes, and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris for both inside and outside of piping and fittings before assembly.

3.02 INSTALLATION:

A. Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated. Refer to individual system specifications for requirements for coordination drawing submittals.

B. Piping shall be exposed, unless indicated otherwise.

C. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.

D. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated on Drawings.

E. Install piping far enough from slabs, beams, joists, columns, walls, and other permanent elements of the building to permit access for painting. Provide space to permit insulation applications, with 3-inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.

F. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.

G. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4-inch ball valve, and short 3/4-inch threaded nipple and cap.

H. Exterior Wall Penetrations: Seal pipe penetrations through exterior walls using sleeves and mechanical sleeve seals.

I. Fire Barrier Penetrations: Where pipes pass through fire rated walls, partitions, ceilings, or floors, the fire rated integrity shall be maintained. Refer to Division 7 for special sealers and materials.

J. Buired Plastic Pipe: Install a yellow insulated copper tracer wire or other approved conductor adjacent to underground nonmetallic piping. The tracer wire shall terminate above ground at each end of the nonmetallic piping. The tracer wire size shall not be less than 18 AWG and unsulation type shall be suitable for direct burial.

3.03 FITTINGS AND SPECIALTIES:

A. Use fittings for all changes in direction and all branch connections.

B. Remake leaking joints using new materials.

C. Install strainers on the supply side of each control valve, pressure reducing or regulating valve, solenoid valve, and elsewhere as indicated.

D. Install unions adjacent to each valve, and at the final connection to each piece of equipment and plumbing fixture having 2-inch and smaller connections, and elsewhere as indicated.

E. Install flanges in piping 2-1/2-inch and larger, where indicated, adjacent to each valve, and at the final connection to each piece of equipment.

F. Install dielectric unions to connect piping materials of dissimilar metals in dry piping systems (gas, compressed air, vacuum).

G. Install dielectric fittings to connect piping materials of dissimilar metals in wet piping systems (water, steam).

H. HDPE to Metallic
   1. Provide an anodeless transition fitting between the underground HDPE gas piping and the above ground metallic piping.

3.04 JOINTS:

A. Steel Pipe Joints:
   1. Pipe 2-inch and Smaller: Thread pipe with tapered pipe threads in accordance with ANSI B2.1. Cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint lubricant or sealant suitable for the service for which the pipe is intended on the male threads at each joint and tighten joint to leave not more than 3 threads exposed.
   2. Pipe Larger than 2-inch:
      a. Weld pipe joints (except for exterior water service pipe) in accordance with ASME Code for Pressure Piping, B31.
      b. Weld pipe joints of exterior water service pipe in accordance with AWWA C206.
      c. Install flanges on all valves, apparatus, and equipment. Weld pipe flanges to pipe ends in accordance with ASME B31.1.0 Code for Pressure Piping. Clean flange faces and install gaskets. Tighten bolts to torque specified by manufacturer of flange and flange bolts, to provide uniform compression of gaskets.

B. Non-ferrous Pipe Joints:
   1. Brazed and Soldered Joints: For copper tube and fitting joints, braze joints in accordance with ANSI B31.1.0 - Standard Code for Pressure Piping, Power Piping, and ANSI B9.1 - Standard Safety Code for Mechanical Refrigeration.
   2. Mechanical Joints: Flared compression fittings may be used for refrigerant lines 3/4-inch and smaller.

3.05 Joints for other piping materials are specified within the respective piping system sections.

3.06 FIELD QUALITY CONTROL:

A. Testing: Refer to individual piping system Specification Sections.

END OF SECTION

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SECTION 15107

CPVC PRESSURE PIPING AND VALVES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Chlorinated polyvinyl chloride (CPVC) pipe and fittings.
   2. Accessories for plastic piping and fittings.

B. Related Work Described Elsewhere:
   1. Section 01330 – Shop Drawings, Product Data and Samples
   2. See Division 15 for Process Piping Specifications
   3. Section 15060 – Supports and Anchors
   4. Section 15088 – Flexible Joints and Couplings

1.2 QUALITY ASSURANCE

A. All plastic pipe, fittings and appurtenances shall be furnished by a single manufacturer who is fully experienced, reputable, and qualified in the manufacture of the items to be furnished. The equipment shall be designed, constructed, and installed in accordance with the best practices and methods and shall comply with these Specifications.

1.3 SUBMITTALS

A. Materials and Shop Drawings:
   1. Shop drawings shall be submitted to the Engineer for approval in accordance with the Division 1 – General Requirements and Section 01330 – Shop Drawings, Product Data and Samples and shall include dimensioning and the technical specification for all piping to be furnished.

B. Additional Information:
   1. Submit to the Engineer, for approval, samples of all materials specified herein, along with the manufacturer's Certificates of Inspection, descriptive literature, illustrations, specifications, installation instructions and related information.

PART 2 PRODUCTS

2.1 CPVC PIPING (Pressure Pipe)

A. Pipe and Fittings:
   1. Pipe: ASTM F441/F441M, Schedule 80.
   2. Fittings:
      a. Flanged: ASME B16.1, ASME B16.5, Class 150.
      b. Socket Welded: ASTM F439, Schedule 80.
      c. Threaded: ASTM F437, Schedule 80; ASME B1.20.1
   3. Joints: Socket welded or Flanged as indicated on the Valve Schedule.
   4. Materials: ASTM D1784.

B. Ball Valves
   1. Description:
      a. Working Pressure: As indicated on valve schedule.
      b. Maximum Fluid Temperature: 80 degrees C.
      c. Full-size ports.
      d. End Connections: ASME B16.1, ASME B16.5, ASME B16.42, flanged.
   2. Operator: Hand lever.
   3. Materials:
      a. ASTM D1784, CPVC.
      b. Seats: PTFE.

C. Swing Check Valves
   1. Description:
      a. Type: Swing-check
      b. Working Pressure: As indicated on valve schedule.
      c. Maximum Fluid Temperature: 80 degrees C
      d. End Connections: Flanged.
   2. Materials:
      a. ASTM D1784, CPVC.
      b. Seal: EPDM.
      c. Hinge Pin: Stainless steel.

D. Butterfly Valves
   1. Description:
      a. Working Pressure: As indicated on valve schedule.
      b. Maximum Fluid Temperature: 80 degrees C.
      c. Body Style: Lugged.
      d. End Connections: ASME B16.5, ASME B16.42, flanged..
   2. Operator: Lever.
   3. Materials:
      a. Bodies: ASTM D1784, CPVC.
      b. Discs: ASTM D1784, CPVC.
      c. Stem: Stainless steel, Type 316.
      d. Seats: PTFE

e. Seals: EPDM rubber.
f. Bearings: PTFE.

2.2 DOUBLE-WALLED CPVC PIPING:

A. Pipe and Fittings:
1. Materials: Double-walled piping shall be 3-inch diameter primary piping with 6-inch diameter secondary containment piping. Both primary and secondary pipes shall be made of Schedule 80 CPVC conforming to ASTM D1785.
2. Fittings: Fittings shall be pre-assembled with integral carrier supports, made of Schedule 80 CPVC confirming to ASTM D1467. Fittings shall be socket type, solvent welded in conformance with ASTM F493. Solvent welded joints shall be watertight.

B. Manufacturers: IPEX Guardian Double Containment Piping System or approved equal.

2.3 FINISHES

A. Coat machined faces of metallic flanges with temporary rust-inhibitive coating.

2.4 ACCESSORIES

A. CPVC Piping:
1. Flange Bolting: Stainless steel, ASTM A193/A193M Grade B8 hex head bolts and ASTM A194/A194M Grade B8 hex head nuts.
2. Flange Gaskets: Full faced, PTFE, according to ASME B16.21.
3. Push-On Joint Seals: EPDM, according to ASTM F477.
4. Solvent Cement: ASTM F493.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install piping and components according to ASME B31.3.

B. Install piping with sufficient slopes for venting or drainage of liquids and condensate to low points.

C. Support exposed piping as specified in Section 15060.

D. Provide expansion joints as specified in Section 15088 to compensate for pipe expansion due to temperature differences.

E. Field Cuts: According to pipe manufacturer's recommendations.

F. Joining:
   1. Perform heat joining according to ASTM D2657.
   2. Perform electrofusion joining according to ASTM F 1290.

G. Insulation: As indicated on Drawings.

H. Underground Piping: As specified in Section 15051 – Process and Utility Piping.

3.2 FIELD QUALITY CONTROL

A. Inspect for damage to pipe lining or coating, or other defects that may be detrimental as determined by Engineer. Repair damaged piping, or provide new, undamaged pipe.

B. Pressure Testing:
   1. As specified in Section 15044 – Pressure Testing of Piping.

END OF SECTION

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SECTION 15129

COUPLINGS AND CONNECTORS

PART 1 GENERAL

1.01 DESCRIPTION:

A. Scope of Work: Furnish and install couplings and connectors of the type(s) and size(s) in the location(s) shown on the Drawings and as specified herein. Pipe supports shall be placed where shown on the Drawings. The General Contractor may install additional pipe supports and flexible couplings to facilitate piping installation, provided that complete details describing their location, the pipe supports and hydraulic thrust protection are submitted. Thrust protection shall be adequate to sustain the force developed by 150% of the design operating pressures specified.

B. Related Work Described Elsewhere:

1. Section 15000 – Mechanical, General Requirements

2. Section 15044 – Pressure Testing of Piping

1.02 QUALITY ASSURANCE:

A. Minimum pressure rating equal to that of the pipeline in which they are to be installed.

B. Couplings and connectors, other than those specified herein, are subject to the Engineer's approval.

1.03 SUBMITTALS:

A. Materials and Shop Drawings:

1. Submit shop drawings in accordance with the Section 01330 – Shop Drawings.

2. Submit manufacturer's catalog data on couplings and connectors. Show manufacturer's model or figure number for each type of coupling or joint for each type of pipe material for which couplings are used.

3. Submit manufacturer's recommended torques to which the coupling bolts shall be tightened for the flexible gasketed sleeve-type compression pipe couplings.

4. Show materials of construction by ASTM reference and grade. Show dimensions.

5. Show number, size and material of construction of the rods and lugs for each thrust harness on the project.

B. Additional Information (Not Applicable)

C. Operating Instructions (Not Applicable)

1.04 PRODUCT DELIVERY STORAGE AND HANDLING:

A. Equipment shall be handled, shipped and stored in accordance with Section 01600 – Common Product Requirements.

1.05 WARRANTY AND GUARANTEES:

A. Provide equipment warranty in accordance with Section 01600 – Common Product Requirements.

PART 2 PRODUCTS

2.01 GENERAL (Not Applicable)

2.02 MATERIALS AND EQUIPMENT:

A. All Couplings and Connectors:

1. Gasket Materials: Composition suitable for exposure to the liquids to be contained within the pipes.

2. Diameters to properly fit the specified types of pipes on which couplings and connectors are to be installed.

B. Sleeve-Type Couplings (when applicable):

1. Exposed couplings (when applicable):

a. Steel middle ring

b. Two steel follower rings

c. Two wedge-section gaskets

d. Sufficient steel bolts to properly compress the gaskets

e. Acceptable manufacturers

(1) Dresser Manufacturing Co. - Style 38

(2) Smith - Blair, Inc. - Style 411

(3) Or equal

2. Buried Couplings (when applicable):

a. Cast - iron middle rings with pipe stops removed

b. Two malleable iron follower rings with ribbed construction

c. Two wedge-section gaskets

d. Bolts and nuts for buried couplings, shall be Type 316 stainless steel conforming to ASTM A 193, Grade B8 for bolts, and ASTM A 194, Grade 8 for nuts. Bolts and nuts greater than 1 1/8 inches shall be carbon steel, ASTM A 307, Grade B, with cadmium plating, ASTM A 165, Type NS

e. Acceptable manufacturers:

(1) Dresser Manufacturing Co. - Style 53

(2) Smith-Blair, Inc. - Style 411

(3) Or equal

C. Split Type (Grooved End) Couplings (when applicable):

1. Constructed from malleable or ductile iron.

2. For use with grooved or shouldered end pipe with minimum wall thickness as required so as not to weaken pipe.

3. Cast in two segments for 3/4-inch through 14-inch pipe sizes, four segments for 15-inch through 24-inch pipe sizes, and six segments for pipe sizes over 24-inch.

4. Coating: Enamel

5. Bolts: Carbon steel

6. Acceptable manufacturers:

a. Victaulic Company of America, Style 77

b. Gustin-Bacon Co.

c. Or equal

D. Flanged Adapters (when applicable):

1. For joining plain end or grooved end pipe to flanged pipes and fittings.

2. Adapters shall conform in size and bolt hole placement to ANSI standards for steel and/or cast iron flanges 125 or 150 pound standard unless otherwise required for connections.

3. Exposed Sleeve Type (Ferrous Piping):

   a. Constructed from steel

   b. Coating: Enamel

   c. Bolts: Carbon steel

   d. Acceptable manufacturers:

      (1) Dresser Manufacturing Co. - Style 128 for cast iron ductile iron and steel pipes with diameters of 2 inches through 96 inches.

      (2) Or equal

4. Exposed Sleeve Type (Stainless Steel Piping):

   a. Construction: Fabricated from Type 316L stainless steel w/ANSI flanges to match the connecting piping.

   b. Finish: Pickled & Passivated or Electropolished to match connected stainless steel piping.

   c. Bolts: Type 316 Stainless Steel as specified within Section 15066 – Stainless Steel Pipe and Fittings.

   d. Acceptable manufacturers:

      (1) Dresser Manufacturing Co. - Style 128-W with lock pins for thrust restraint and other options as detailed above.

      (2) Or Engineer approved equal

5. Buried Sleeve Type:

   a. Constructed from cast iron

   b. Bolts and nuts for buried sleeves shall be Type 316 stainless steel conforming to ASTM A 193, Grade B8 for bolts, and ASTM A 194, Grade 8 for nuts and washers. Bolts and nuts greater than 1 1/8 inches shall be carbon steel, ASTM A 307, Grade B, with cadmium plating, ASTM A 165, Type NS

   c. Acceptable manufacturers:

      (1) Dresser Manufacturing Co. - Style 127 locking type for cast iron, ductile iron, asbestos cement and steel pipes with diameters of 3 inches through 12 inches.

      (2) Or equal

6. Split Type (Ferrous Piping):

   a. Constructed from malleable or ductile iron

   b. For use with grooved or shouldered end pipe

   c. Coating: Enamel

   d. Acceptable manufacturers:

      (1) Victaulic Company of America - Style 741 for pipe diameters of 2 inches through 12 inches

      (2) Victaulic Company of America - Style 742 for pipe diameters of 14 inches through 16 inches.

      (3) Or equal

7. Split Type (Stainless Steel Piping):

   a. Construction: Cast Type 316 Stainless Steel, ASTM A 351 Grade CF-8M w/ EPDM gasket material.

   b. For use with grooved or shouldered end pipe

   c. Finish: Smooth Electropolished

   d. Acceptable manufacturers:

      (1) Victaulic Company of America - Style 77S for pipe diameters of 2 inches through 12 inches with pressures less than 300 psi.

      (2) Piedmont Pacific Corporation - Style K for pipe diameters of 2 inches through 8 inches with pressures less than 200 psi, Style B for pipe diameters of 2 inches through 4 inches with pressures less than 300 psi.

E. Deflection Joints:

1. Joints designed to permit a nominal maximum deflection of 15 degrees in all directions from the axis of the adjacent pipe length, will prevent pulling apart, and will remain watertight at any angle of deflection under 15 degrees.

2. Material to be manufactured from a composition material suitable for exposure to the liquid, pressure and temperature to be contained within the pipe.

3. Supplied with control rods as required.

F. Transition Couplings: Transition couplings for connecting different pipes having different outside diameters shall be steel: Dresser Style 62 or 162, Rockwell Series 413, Baker Series 212 or 240, or equal.

2.03 ACCESSORIES:

A. Joint Harnesses:

1. Tie bolts or studs shall be as shown in the following table. Bolt or stud material shall conform to ASTM B 193, Grade B7. Nuts shall conform to ASTM A 194, Grade 2H. Lug material shall conform to ASTM A 36, ASTM A 283, Grade B, C, or D, or ASTM A 285, Grade C. Lug dimensions shall be as shown in AWWA Manual M11, Table 19.7.

TIE BOLTS OR STUD REQUIREMENTS
FOR FLEXIBLE PIPE COUPLINGS

Tie Bolt or Stud Minimum Requirements

	150 psi		300 psi	
Nominal Pipe Size (Inches)	No. Bolts or Studs	Size (Inches)	No. Bolts or Studs	Size (Inches)
2	2	5/8	2	5/8
3	2	5/8	2	5/8
4	2	5/8	2	4/8
6	2	5/8	2	5/8
8	2	5/8	2	5/8
10	2	5/8	2	5/8
12	2	3/4	2	7/8
14	2	3/4	2	1
16	2	7/8	2	1-1/4
18	2	1	2	1-3/8
20	2	1	2	1-1/2
24	4	1	4	1-1/4
30	4	1-1/8	4	1-1/2
36	4	1-1/4	4	1-3/4
42	4	1-1/2	6	1-5/8
48	6	1-3/8	6	1-7/8
54	6	1-1/2	6	2-1/4
60	6	1-5/8	8	2
66	6	1-3/4	8	2-1/4
72	6	1-7/8	10	2-1/4
84	6	2-1/4	12	2-1/4
96	8	2-1/4	14	2-1/4

2. Select number and size of bolts based on the test pressure shown in Section 15044 – Pressure Testing of Piping. For test pressures less than or equal to 150 psi, use the 150-psi design in the table above. For test pressures between 150 and 300 psi, use the 300-psi design in the table above.

3. Provide washer for each lug. Washer material shall be the same as the nuts. Minimum washer thickness shall be 1/8-inch.

B. Bolts and Nuts for Flanges:

1. Bolts and nuts for flanges located indoors and in enclosed vaults and structures shall be carbon steel, ASTM A 307, Grade B.

2. Bolts and nuts for buried and submerged flanges, flanges in open vaults and structures, and flanges located outdoors above ground shall be Type 316 stainless steel conforming to ASTM A 193, Grade B8M for bolts, and ASTM A 194,

Grade 8M for nuts. Bolts and nuts greater than 1 1/8-inches shall be carbon steel, ASTM A 307, Grade B., with cadmium plating, ASTM A 165, Type NS.

3. Bolts used in flange insulation kits shall conform to ASTM B 193, Grade B7. Nuts shall comply with ASTM A 194, Grade 2H.

4. Provide washers for each unit. Washers shall be of the same material as the nuts.

2.04 SPARE PARTS (Not Applicable)

2.05 QUALITY CONTROL:

A. General Contractor shall follow Manufacturer's and Supplier's recommended product quality control specifics as required for this project.

PART 3 - EXECUTION

3.01 PREPARATION (Not Applicable)

3.02 INSTALLATION:

A. Sleeve Type Couplings (when applicable):

1. Thoroughly clean pipe ends for a distance of 8 inches from the ends prior to installing couplings, and use soapy water as a gasket lubricant.

2. Slip a follower ring and gasket (in that order) over each pipe and place the middle ring centered over the joint.

3. Insert the other length into the middle ring the proper distance.

4. Press the gaskets and followers evenly and firmly into the middle ring flares.

5. Insert the bolts, finger tighten and progressively tighten diametrically opposite nuts uniformly around the adapter with a torque wrench applying the torque recommended by the manufacturer.

6. Insert and tighten the tapered threaded lock pins.

7. Insert the nuts and bolts for the flange, finger tighten and progressively tighten diametrically opposite bolts uniformly around the flange to the torque recommended by the manufacturer.

B. Split Type Flange Adapters (when applicable): Install in the same manner as Split Type Couplings.

C. Buried Couplings, Adapters and Connectors (when applicable): Thoroughly coat all exterior surfaces, including nuts and bolts, after assembly and inspection by the Engineer with a heavy-bodied bituminous mastic as approved by the Engineer.

D. Install thrust rods, supports, and other provisions to properly support pipe weight and axial equipment loads.

3.03 INSPECTION AND TESTING:

A. Hydrostatically test pipe couplings and joints in place with the pipe being tested. Test in accordance with Sections 15044 – Pressure Testing of Piping.

3.04 START-UP AND INSTRUCTION (Not Applicable)

END OF SECTION

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SECTION 15140

WATER DISTRIBUTION PIPING

PART 1 GENERAL

1.01 SUMMARY:

A. Section includes the following:
   1. Water Distribution Piping System:
      a. Potable cold and hot, water system.
      b. Tepid water system.
      c. Recirculated hot water system.
   2. Service Water Distribution System.
      a. Lake Mead Stabilized Water distribution system.
      b. Non-Potable water distribution system.
      c. Piping, fittings, and specialties.

1.02 DEFINITIONS:

A. Water Distribution Piping: A pipe within the building or on the premises which conveys water from the water service pipe, or meter, to the points of usage. This definition includes all potable, service, and effluent water piping.

B. Potable Water Piping: The pipe from the water main, or other source of potable water supply, to the water distributing system of the building served.

C. Service Water Piping: A pipe within the building or on the premises which conveys service water to the points of usage.

D. Pipe sizes used in this Specification are Nominal Pipe Size (NPS).

1.03 SUBMITTALS:

A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section:
   1. Product data for each piping specialty and valve specified.
   2. Welders' Certificates certifying that welders comply with requirements specified in Quality Assurance below.
   3. Certification of Compliance with ASME and UL fabrication requirements specified below.

B. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01730, Operation and Maintenance Data for items included under this Section.

C. Test and Inspection Report: Submit a written report to CONSTRUCTION MANAGER documenting testing and/or inspection results. The report shall be prepared as noted under Section 15950 – Testing, Adjusting & Balancing.

1.04 QUALITY ASSURANCE:

A. Regulatory Requirements: Comply with the provisions of the following:
   1. ASME B 31.9 "Building Services Piping" for materials, products, and installation. Safety valves and pressure valves shall bear the appropriate ASME label.
   2. ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualification" for Qualifications for Welding Processes and Operators.
   3. Ohio Plumbing Code.

1.05 SEQUENCING AND SCHEDULING:

A. Coordinate the size and location of concrete equipment pads. Cast anchor bolt inserts into pad.

B. Coordinate the installation of pipe sleeves for foundation wall penetrations.

1.06 EXTRA STOCK:

A. Maintenance Stock: Furnish one valve key for each key-operated hydrant, bibb, or faucet installed.

PART 2 PRODUCTS

2.01 MANUFACTURERS:

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
   1. Pressure Reducing Valve:
      a. Cla-Val Co.
      b. Golden Anderson.
   2. Backflow Preventer:
      a. Febco Sales, Inc., Subs. of Charles M. Bailey Co., Inc.
      b. Hersey Products, Inc.
      c. ITT Lawler, Fluid Handling Division.
      d. Watts Regulator Co.
      e. Wilkins.
   3. Pressure Gauge:
      a. Trerice, Model No. 450LFB.
      b. Ashcroft, Model Type 1279.
   4. Hose:
      a. B.F. Goodrich.
      b. Uniroyal.
      c. Or Approved Equal
   5. Flushing Hose:
      a. B.F. Goodrich.
      b. National Fire Hose.
      c. Uniroyal.

6. Y-Pattern Strainer:
    a. Armstrong Machine Works.
    b. Hoffman Specialty ITT, Fluid Handling Division.
    c. Spirax Sarco.
    d. Trane Co.
    e. Victaulic Co. of America (low-pressure applications only).
    f. Watts Regulator Co.

2.02 PIPING MATERIALS:

A. CPVC Pipe
1. Pipe: Rigid Chlorinated Polyvinyl Chloride (CPVC) compound, Type IV Grade I, with a Cell Clasfication of 23447 as defined in ASTM D1784.
2. Pipe Schedule: Schedule 80.
3. Pressure Rating: 100 PSIG.
4. Temperature Ratingt: 180 degree F.
5. Joint Type: Solvent Welded.
6. Fittings: CPVC, Schedule 80, socket type, ASTM F439.
7. Threaded Fittings: Only female threaded fittings with stainless steel ring or brass insert are acceptable. Threaded male fittings are not acceptable.
8. Flanged Fitting: CPVC, 150 lb, flat-face, Schedule 80, socket type.

B. Galvanized Pipe
1. Pipe: Galvanized steel, Schedule 40, ASTM A 120 seamless or electric welded. Mill galvanized.
2. Size: ¼" to 4".
3. Pipe Schedule: 40.
4. Normal operating pressure: 150 PSIG.
5. Normal Maximum operating Temperature: 200 F.
6. Type of Joints:
    a. ¼" to 2": Screwed
    b. 2-1/2" and larger: Mechanical Couplings
7. Fittings:
    a. ¼" – 2": Galvanized malleable iron, 150-pound class, screwed. ANSI Standard B16.3.
    b. 2" and larger: Galvanized steel, grooved end for mechanical coupling. Gustin-Bacon, Victaulic.
8. Unions: ¼" – 2": Galvanized malleable iron, 250-pound class, rail-road type, with brass seats.
9. Couplings: 2-1/2" and larger: Malleable iron mechanical coupling with Grade M chlorinated butyl rubber gasket. Gustin-Bacon Series 100, Victaulic Style 77.
10. Flanges: 2-1/2-inch through 12-inch: Galvanized flanged adapter nipples, 125-pound flat-face. Gustin-Bacon No. 54, Victaulic Style 77.
11. Flange Gaskets: 1/16-inch Teflon, full-face type, or Durco "Taskline" Teflon.
12. Thread Sealant: Teflon tape.

2.03 Plumbing Valves

A. CPVC Piping:
1. Ball Valve: (2" and smaller) Schedule 80, True-Union ball valve. Valve pressure rating 250 PSI at 73 degrees F water non-shock full-port, EPDM O-rings. Compliant with ASTM F1970, NSF/ANSI Standard 14, NSF/ANSI Standard 61 Annex G.
2. Butterfly Valve: (2-1/2" and Larger) Schedule 80, Wafer Style. Valve pressure rating 150 PSI at 73 degrees F water, EPDM O-rings and boot. Flanged end connections compatible with ANSI

B16.5 Class 150, Lever handle. Compliant with ASTM F1970, NSF/ANSI Standard 14, NSF/ANSI Standard 61 Annex G.

3. Ball Check Valve: Schedule 80, True-Union check valve. Valve pressure rating 150 PSI at 73 degrees F water non-shock, EPDM O-rings. Compliant with ASTM F1970, NSF/ANSI Standard 14, NSF/ANSI Standard 61 Annex G.

B. Galvanized Piping:
   1. Ball Valve: Brass or bronze body, full port, blow-out proof stem, Teflon seats and seals.

2.04 SPECIAL DUTY VALVES:

A. Pressure Reducing Valve: Pressure reducing valves shall maintain a constant downstream pressure regardless of varying inlet pressure. Valves shall be globe pattern or angle pattern as required by the installation shown on Drawings and/or as called for on Schedule.
   1. Valves shall be hydraulically operated, pilot-controlled and of the diaphragm-operated type; the diaphragm shall be nylon fabric-reinforced synthetic rubber and the disc shall have a rectangular cross-section. The valve may also be a self-contained differential piston type with the small end of the piston representing one of the sealing contacts, and the large end representing the effective area to provide the closing force.
   2. The external pilot valves and piping shall be arranged for either pressure sustaining or pressure reducing service for the pressure range as listed on Schedule. The pilot control shall be direct-acting, adjustable, spring-loaded, diaphragm type.
   3. Valves shall be cast iron or semi-steel body with bronze trim and be designed for 150 psi working pressures. Valves shall be fitted with renewable seals and designed so that the seats can be replaced without removing the valve from the piping. Valves shall be furnished with a valve position indicator, flow stabilizer, shutoff valves and a strainer in the pilot system. Flow symbols shall be cast in the valve body or the inlet end shall be identified to facilitate correct installation in the piping. Valve shall have ANSI 125-pound flanged connections.

B. Pressure Sustaining Valve: Pressure sustaining valves shall maintain a constant upstream pressure regardless of varying downstream demands. Valves shall be globe pattern or angle pattern as required by the installation shown on Drawings and/or as called for on Schedule.
   1. Valves shall be hydraulically operated, pilot-controlled and of the diaphragm-operated type; the diaphragm shall be nylon fabric-reinforced synthetic rubber and the disc shall have a rectangular cross-section. The valve may also be a self-contained differential piston type with the small end of the piston representing one of the sealing contacts, and the large end representing the effective area to provide the closing force.
   2. The external pilot valves and piping shall be arranged for either pressure sustaining or pressure reducing service for the pressure range as listed on Schedule. The pilot control shall be direct-acting, adjustable, spring-loaded, diaphragm type.

C. Valves shall be cast iron or semi-steel body with bronze trim and be designed for 150 psi working pressures. Valves shall be fitted with renewable seals and designed so that the seats can be replaced without removing the valve from the piping. Valves shall be furnished with a valve position indicator, flow stabilizer, shutoff valves and a strainer in the pilot system. Flow symbols shall be cast in the valve body or the inlet end shall be identified to facilitate correct installation in the piping. Valve shall have ANSI 125-pound flanged connections.

2.05 PIPING SPECIALTIES:

A. Water Hammer Arresters: Bellows type, with stainless steel casing and bellows, pressure rated for 250 psi, tested and certified in accordance with PDI Standard WH-201.

B. Y-Strainers: 1/4-inch through 2-inch, bronze, screwed, 250-pound or 300-pound ASTM A 61 or A 62 with stainless steel or monel screen having 3/64-inch perforations.

C. Backflow Preventers: Reduced pressure principle assembly consisting of shutoff valves on inlet and outlet, and strainer on inlet. Assemblies shall include test cocks and pressure-differential relief valve located between two positive seating check valves, and comply with requirements of ASSE Standard 1013.
   1. Operation shall be completely automatic. All parts must be removable or replaceable without removal of the unit from the line. The total head loss through the complete backflow assembly shall not exceed 15 psi at the rated flow listed in the Schedule.
   2. Main valve body and cover shall be bronze ASTM B 61 or cast iron ASTM A 26 interior epoxy coated, main valve trim to be bronze ASTM B 61 and differential relief valve shall be bronze ASTM B 61 with 304 stainless steel trim. Two isolating gate valves and air gap drain fitting shall be included.
   3. A test kit shall be furnished incorporating a differential pressure gauge and appropriate valving and hoses for easy field hookup. The unit shall be capable of a working pressure to 175 psig and working temperature to 200 degrees F. The gauge dial shall be 0-15 psig with 1-pound major graduations and 0.2-pound minor graduations.
      a. Hose lengths shall be at least 3 feet, colors matched to valves, and shall have hose end fittings 1/4-inch female quick couplers. The kit shall include a set of brass adapters if required for the backflow preventer supplied.
   4. Provide a spare parts kit for each size of backflow preventer supplied.

D. Pressure Gauge: Pressure gauges shall be liquid filled with a fiberglass-reinforced polypropylene case and ring, 4-1/2-inch steel dial with white background and black markings, clear glass window, aluminum pointer with black finish, brass movement with milled teeth, bourdon tube of drawn grade A phosphor bronze with silver-brazed joints, and a 1/2-inch NPT brass bottom outlet with shutoff valve. Accuracy shall be 1/2 percent of full scale. Scale range shall be 0 to 100 psi unless noted otherwise. Seals shall be provided for all non-clean water applications. Seals and diaphragms shall be suitable for the service provided.

E. Hose: A 50-foot length of 3/4-inch commercial-duty reinforced rubber hose with garden hose connections shall be provided at each hose station shown on Drawings. Hose shall be capable of handling extensive hot water (200 degrees F) use. Rubber cover shall be resistant to oils, chemicals, abrasion, and weather and have a 600 psi burst pressure. Provide heavy-duty, 175-foot capacity,

wall-mounted plastic hose storage reel with hose guide at each hose station location. Hose storage reel shall come with a minimum 3-foot connecting hose to the hose bib.

1. Hose Accessories: Provide hose hanger for each hose connection. The hose hanger shall be capable of holding 50 Feet of hose and constructed of stainless steel. Hose hanger shall be Grainger Part # 21AC25 or equal.
2. Hose Accessories: Provide adjustable hose nozzle with shutoff valve. Nozzle shal be High-Flow Fire Hose Spray Tip with adjustable spray/Shutoff handle. Nozzle shall be Grainger part # 2LPN3 or equal.

F. Flushing Hose: 50-foot lengths of 1-1/2-inch collapsible fire hose for a 300 psi working pressure shall be furnished in the number and locations as noted on drawings.Hoses shall be 100 percent synthetic, and resistant to mildew and rot.

1. Hose Accessories: For each hose station, provide Fire Hose Rack for the 1-1/2" and capacity as noted. Hose Reel shall be steel construction with Red Enamel finish or Stainless Steel construction. GRAINGER Part #: 6APE4 or equal.
2. Hose Accessoires: For each hose station, provide Fire Hose Nozzle with Pistol Grip, Selector Ring, Adjustable Spray pattern, and Valve. Nozzle shall be corrosion resistant aluminum construction. GRAINGER Part # 15Z054 or equal.

2.06 VALVE FREEZE PROTECTION

A. Where indicated here-in or on the plans, provide FRP enclosure over the valve assemble.

B. Enclosure shall be FRP construction with hinged top for opening and accessing the valve. Provide with continuous hinge at rear. Provide with lift handle and latch. Provide with anchoring hardware.

C. Enclosure shal be sized so the valve can be a service from the open top. Provide with sidewall pipe access.

PART 3 EXECUTION

3.01 EXAMINATION:

A. Verify all dimensions by field measurements. Verify that all water distribution piping may be installed in accordance with pertinent codes and regulations, the original design, and the referenced standards.

B. Examine rough-in requirements for plumbing fixtures and other equipment having water connections to verify actual locations of piping connections prior to installation.

C. Do not proceed until unsatisfactory conditions have been corrected.

3.02 PIPING INSTALLATION:

A. Install piping with 1/32-inch per foot (1/4 percent) downward slope towards drain point.

B. Install piping to allow for thermal expansion per the manufacturers requirements. Piping layout and expansion systems shown on the plans is based on nominal 80 degree F. Construction Manager shall follow the manufacturer's instructions for thermal expansion if piping temperature is above or below the nominal temperature.

3.03 HANGERS AND SUPPORTS:

A. Hanger, supports, and anchor devices are specified in Section 15060, Supports and Anchors. Conform to the table below for maximum spacing of supports.

B. Install the following pipe attachments:
1. Adjustable steel clevis hangers for individual horizontal runs.

C. Install hangers with the following rod sizes and maximum spacing:

Nominal Pipe Size	Max. Span Feet	Min. Rod Size Inches
1	7	3/8
1-1/2	9	3/8
2	10	3/8
3	12	1/2
3-1/2	13	1/2
4	14	5/8
5	16	5/8
6	17	3/4
8	19	7/8
10	22	7/8
12	23	7/8

D. Support vertical runs at each floor.

3.04 PIPE AND TUBE JOINT CONSTRUCTION:

A. Threaded Joints: Conform to ANSI B1.20.1, tapered pipe threads for field cut threads.

3.05 SERVICE ENTRANCE:

A. Extend water distribution piping to connect to water service piping, of size and in location for service entrance to building.

B. Install sleeve and mechanical sleeve seal at penetrations through foundation wall for watertight installation.

C. Install shutoff valve at service entrance inside building.

D. Install lead-free Backflow Preventer(s) per the manufacturer's requirements..

3.06 VALVE APPLICATIONS:

A. General Duty Valve Applications: Drawings indicate valve types to be used. Where specific valve types are not indicated the following requirements apply:
   1. Shut-off duty: Use gate, ball, and butterfly valves.
   2. Throttling duty: Use globe and butterfly valves.

3.07 INSTALLATION OF VALVES:

A. Install sectional valves on each branch and riser, close to main, where branch or riser serves two or more plumbing fixtures or equipment connections, and elsewhere as indicated. Install shutoff valves on inlet of each plumbing equipment item, and on inlet of each plumbing fixture, and elsewhere as indicated.

B. Install drain valves on each plumbing equipment item, located to completely drain equipment for service or repair. Install drain valves at the base of each riser, at low points of horizontal runs, and elsewhere as required to completely drain distribution piping system.

C. Install swing check valves on discharge side of each pump, and elsewhere as indicated.

D. Install balance cocks in each hot water recirculating loop, and elsewhere as indicated.

3.08 INSTALLATION OF PIPING SPECIALTIES:

A. Install backflow preventers in compliance with the plumbing code and authority having jurisdiction. Pipe relief outlet without valves to nearest floor drain or equipment drain.

B. Install pressure regulating valves with inlet and outlet shutoff valves, and balance cock bypass. Install pressure gauge on valve outlet.

3.09 EQUIPMENT CONNECTIONS:

A. Piping Runouts to Fixtures: Provide hot and cold water piping runouts to fixtures of sizes indicated, but in no case smaller than required by Plumbing Code.

B. Mechanical Equipment Connections: Connect hot, cold, service or plant effluent water piping to mechanical equipment as indicated. Provide shutoff valve and union for each connection; provide drain valve on drain connection. For connections 2-1/2-inch and larger, use flanges instead of unions.

C. Construction Manager shall test and certify the backflow prevention device(s) at time of installation in accordance with the applicable local, state and federal standards. The test report shall be mailed to the local Water Engineering Office. A copy of the report shasll be submitted to the Construction Manager.

D. Service and Stabilized Lake Mead Water Connections: At each sill cock, hose bibb, and hydrant, a sign shall be placed and shall read in 1-inch-high letters as follows: THIS WATER NOT SAFE FOR DRINKING.

E. Flushing Connections: Where called for on Drawings, a valved flushing connection shall be furnished. The connection shall consist of a threaded pipe and valve suitable for hookup to the flushing hose. The connection shall be made of 1-1/2-inch diameter pipe unless otherwise noted on Drawings.

3.11 FLUSHING HOSE AND HOSE BIBBS:

A. Install hose racks and provided required ancillary support to install the hose racks. See specification 15060 for specific material requirements.

B. Install hose racks at all hose bidd and flushing hose connection and where indicated on the drawings.

3.12 VALVE FREEZE PROTECTION:

A. Provide valve protection boxes (freeze protection) for Backflow Preventor Valves and Pressure Sustaining/Pressure Relief Valves with external control tubing.

3.13 FIELD QUALITY CONTROL:

1. Inspect water distribution piping as follows: Do not enclose, cover, or put into operation water distribution piping system until it has been inspected and approved by the authority having jurisdiction.
2. During the progress of the installation, notify the plumbing official having jurisdiction at least 24 hours prior to the time such inspection must be made. Perform tests specified below in the presence of the plumbing official.
    a. Rough-in Inspection: Arrange for inspection of the piping system before concealed or closed-in, after system is roughed-in, and prior to setting fixtures.

b. Final Inspection: Arrange for a final inspection by the plumbing official to observe the tests specified below and to ensure compliance with the requirements of the plumbing code.

3. Reinspections: Whenever the plumbing official finds that the piping system will not pass the test or inspection, make the required corrections and arrange for reinspection by the plumbing official.
4. Prepare inspection reports, signed by the plumbing official.

B. Test water distribution piping as follows:
1. Test for leaks and defects of all new water distribution piping systems and parts of existing systems which have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with a diagram of the portion of the system tested.
2. Leave uncovered and unconcealed all new, altered, extended, or replaced water distribution piping until it has been tested and approved. Expose all such work for testing that has been covered or concealed before it has been tested and approved.
3. Cap, and subject the piping system to a static water pressure of 50 psig above the operating pressure without exceeding the pressure rating of the piping system materials. Isolate the test source and allow to stand for a period of four hours. Leaks and loss in test pressure constitute defects which must be repaired.
4. Repair all leaks and defects using new materials and retest system or portion thereof until satisfactory results are obtained.
5. Prepare reports for all tests and required corrective action.

3.14 ADJUSTING AND CLEANING:

A. Clean and disinfect potable water distribution piping as follows:
1. Purge all new water distribution piping systems and parts of existing systems which have been altered, extended, or repaired prior to use.
2. Use the purging and disinfecting procedure prescribed by the authority having jurisdiction, or in case a method is not prescribed by that authority, the procedure described in either AWWA C651, or AWWA D652, or as described below:
a. Flush the piping system with clean, potable water until dirty water does not appear at the points of outlet.
b. Fill the system, or part thereof, with a water/chlorine solution containing at least 50 parts per million of chlorine. Isolate (valve off) the system, or part thereof, and allow to stand for 24 hours.
c. Alternately fill the system, or part thereof, with a water/chlorine solution containing at least 200 parts per million of chlorine and isolate and allow to stand for three hours.
d. Following the allowed standing time, flush the system with clean potable water until chlorine does not remain in the water coming from the system.
e. Submit water samples in sterile bottles to the authority having jurisdiction. Repeat the procedure if the biological examination made by the authority shows evidence of contamination.

B. Prepare reports for all purging and disinfecting activities.

3.15 COMMISSIONING:

A. Fill the system.

B. Check compression tanks to determine that they are not air bound and that the system is completely full of water.

C. Before operating the system perform these steps:
   1. Open valves to full open position. Close drain valves, hydrants, and sill cocks.
   2. Remove and clean strainers.
   3. Lubricate pump motors and bearings (where required).

END OF SECTION

TETRA TECH	**Plumbing Fixtures** **Technical Specification**	**SPECIFICATION NUMBER: 15410** **PROJECT NUMBER: 117-7502016-L09** **PROJECT NAME: Weir Dewatering Treatment**

SPECIFICATION REVISION INDEX

Revision No.	Revision Date	Issued for	Signatures				
			Prepared By	Reviewed By	Project Engineer	Project Manager	Client
A	11/28/2016	60% Submittal	CMF	JG	JG	STD	
B	2/15/2017	75% Submittal	CMF	JG	JG	STD	

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SECTION 15410

PLUMBING FIXTURES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Plumbing fixtures and trim. The types of fixtures specified include:
   1. Emergency Showers.

1.02 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
   1. Product data and installation instructions for each fixture, faucet, specialties, accessories, and trim specified; clearly indicate rated capacities of selected models of water coolers.
   2. Detail dimensions, rough-in requirements, required clearances, and methods of assembly of components and anchorages.
      a. Coordinate requirements with architectural woodwork Shop Drawings specified in Division 6 for fixtures installed in countertops and cabinets. Furnish templates for use in woodwork shop.
   3. Manufacturer's electrical requirements and wiring diagrams for power supply to units. Clearly differentiate between portions of wiring that are factory-installed and field-installed portions.
   4. Manufacturer's standard color charts for cabinet finishes and fixture colors.

B. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01730, Operation and Maintenance Data for items included under this Section.

C. Quality Control Submittals:
   1. Certification of compliance with specified ANSI, UL, and ASHRAE standards.
   2. Certification of compliance with performance verification requirements specified in this Section.

1.03 QUALITY ASSURANCE

A. Codes and Standards:
   1. ASHRAE Standard 18, "Method of Testing for Rating Drinking Water Coolers with Self-Contained Mechanical Refrigeration Systems."
   2. ARI Standard 1010, "Drinking-Fountains and Self-Contained Mechanically Refrigerated Drinking Water Coolers."
   3. ANSI Standard A117.1, "Specifications for Making Buildings and Facilities Accessible to and Usable by Physically Handicapped People."
   4. Public Law 90-480, "Architectural Barriers Act of 1968."
   5. UL Standard 399, "Drinking-Water Coolers."

1.04 DELIVERY, STORAGE, AND HANDLING

A. Store fixtures where environmental conditions are uniformly maintained within the manufacturer's recommended temperatures to prevent damage.

B. Store fixtures and trim in the manufacturer's original shipping containers. Do not stack containers or store in such a manner that may cause damage to the fixture or trim.

1.05 SEQUENCE AND SCHEDULING

A. Schedule rough-in installations with the installation of other building components.

1.06 MAINTENANCE

A. Extra Stock:
   1. Furnish special wrenches and other devices necessary for servicing plumbing fixtures and trim to Engineer with receipt in a quantity of one device for each ten fixtures.
   2. Furnish faucet repair kits complete with all necessary washers, springs, pins, retainers, packings, O-rings, sleeves, and seats in a quantity of one kit for each 40 faucets.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
   1. Emergency Showers and Eye/Face Wash:
      a. Bradley Western.
      b. Haws.
      c. Speakman.

2.02 FIXTURES

A. Emergency Shower and Eye/Face Wash: Provide freestanding as noted on Schedule.
   1. Unit shall be 10-inch-diameter emergency shower with deluge shower head, 1-inch full port stay-open quick opening ball valve with 30-inch-long rigid pull rod, integral 8-inch-diameter pull ring, and interconnecting fittings. Head shall be mounted approximately 24 inches from wall.
      a. Materials: Schedule 40 hot-dipped galvanized steel pipe and fittings with powder coated cast iron 9” diameter floor flange.
   2. Showerheads shall be self-cleaning impeller type with capacity of 33 gpm at 50 psi.
      a. Material: ABS Plastic
   3. Eye/face wash shall or supported from freestanding emergency shower with stay-open ball valve activated by "trigger action" push bar and mounting brackets. Capacity of 2.5 gpm at 30 psi, 1 1/4-inch IPS supply and waste. Eye/face wash head shall feature inverted directional laminar flow which achieves zero vertical velocity supplied by an internal flow control. Provide with safety covers for eyewash head.
      a. Materials: Stainless bowl

4. Unit shall have integral temperature-actuated freeze and scald protection valves. When temperature drops below 40°F or rises above 95°F, drain valve shall automatically open to allow water to circulate through unit. Water shall circulate until water temperature returned to within 40°F - 95°F.

B. Emergency Shower Combination Strobe Light and Alarm Horn.
1. Visual Signal: Weatherproof amber strobe light with shatter-resistant lens, peak candle power of 1,400,000 and flash rate of 65 FPM.
2. Audible Signal: Weatherpoof horn with distinctive urgent signal. Volume preset at 100 db at 10 feet. Volume shall be adjustable at unit.
3. Flow Switch: 1-1/4" IPS double pole, double throw waterproof switch for installation in water supply line to emergency fixture. Flow switch shall activate at 2.4 GPM and deactivate at 2.0 GPM.
4. Remote Sensing: Flow switch shall have auxiliary contacts for remote sensing.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify all dimensions by field measurements. Verify that all plumbing fixtures shall be installed in accordance with pertinent codes and regulations, the original design, and the referenced standards.

B. Examine rough-in for potable water and waste piping systems to verify actual locations of piping connections prior to installing fixtures.

C. Examine walls, floors, and cabinets for suitable conditions where fixtures are to be installed.

D. Do not proceed until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install plumbing fixtures level and plumb, in accordance with fixture manufacturer's written instructions, rough-in drawings, pertinent codes and regulations, the original design, and the referenced standards.

B. Comply with the installation requirements of ANSI A117.1 and Public Law 90-480 with respect to plumbing fixtures for the physically handicapped.

C. Fasten plumbing fixtures securely to supports or building structure. Secure supplies behind or within wall construction to provide rigid installation.

3.03 FIELD QUALITY CONTROL

A. Test fixtures to demonstrate proper operation upon completion of installation and after units are water pressurized. Replace malfunctioning units, then retest.

B. Inspect each installed unit for damage. Replace damaged fixtures.

3.04 ADJUSTING

A. Adjust water pressure at drinking fountains, faucets, shower valves, and flush valves to provide proper flow and stream.

B. Replace washers of leaking or dripping faucets and stops.

3.05 CLEANING

A. Clean fixtures, trim, and strainers using manufacturer's recommended cleaning methods and materials.

3.06 PROTECTION

A. Provide protective covering for installed fixtures, water coolers, and trim.

B. Do not allow use of fixtures for temporary facilities unless expressly approved in writing by Engineer.

END OF SECTION

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SPECIFICATION REVISION INDEX

Revision No.	Revision Date	Issued for	Signatures				
			Prepared By	Reviewed By	Project Engineer	Project Manager	Client
A	11/28/2016	60% Submittal	CMF	JG	JG	STD	
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SECTION 15420

EMERGENCY PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Emergency showers.
2. Eyewash equipment.
3. Eye/face wash equipment.
4. Combination units.
5. Water-tempering equipment.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Diagram power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ANSI Standard: Comply with ANSI Z358.1, "Emergency Eyewash and Shower Equipment."

C. NSF Standard: Comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects," for fixture materials that will be in contact with potable water.

D. Regulatory Requirements: Comply with requirements in ICC/ANSI A117.1, "Accessible and Usable Buildings and Facilities"[; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act";] for plumbing fixtures for people with disabilities.

PART 2 - PRODUCTS

2.1 EMERGENCY SHOWERS

A. Freestanding, Plumbed Emergency Showers, <Insert drawing designation>:
   1. Supply Piping: [NPS 1 (DN 25)] [NPS 1-1/4 (DN 32)] [galvanized steel] [chrome-plated brass or stainless steel] [PVC] with flow regulator and stay-open control valve.
   2. Control-Valve Actuator: [Pull rod] [Foot treadle] <Insert actuator>.
   3. Shower Head: 8-inch- (200-mm-) minimum diameter, [chrome-plated brass, stainless steel, or plastic] <Insert material>.
   4. Mounting: Pedestal.

B. Freeze-Protected, Plumbed Emergency Showers, <Insert drawing designation>:
   1. Capacity: Not less than 20 gpm (76 L/min.) for at least 15 minutes.
   2. Supply Piping: NPS 1-1/4 (DN 32) galvanized steel with flow regulator and stay-open control valve.
   3. Control-Valve Actuator: Pull rod.
   4. Shower Head: 8-inch- (200-mm-) minimum diameter, [chrome-plated brass, stainless steel, or plastic] <Insert material>.
   5. Heating System: [120] [240]-V ac electric, and insulation with protective jacket.
   6. Mounting: Pedestal.

2.2 EYEWASH EQUIPMENT

A. Standard, Freestanding, Plumbed Eyewash Units, <Insert drawing designation>:
   1. Capacity: Not less than 0.4 gpm (1.5 L/min.) for at least 15 minutes.
   2. Supply Piping: NPS 1/2 (DN 15) chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
   3. Control-Valve Actuator: [Paddle] [Treadle] <Insert actuator>.
   4. Spray-Head Assembly: Two receptor-mounted spray heads.
   5. Receptor: [Chrome-plated brass or stainless-steel] [Plastic] bowl.
   6. Drain Piping: [NPS 1-1/4 (DN 32) minimum, chrome-plated brass, receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2/CSA B125.2] [Include galvanized-steel indirect connection to drainage system].
   7. Mounting: Pedestal.

B. Accessible, Freestanding, Plumbed Eyewash Units, <Insert drawing designation>:
   1. Capacity: Not less than 0.4 gpm (1.5 L/min.) for at least 15 minutes.
   2. Supply Piping: NPS 1/2 (DN 15) chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
   3. Control-Valve Actuator: [Paddle] <Insert actuator>.
   4. Spray-Head Assembly: Two receptor-mounted spray heads.
   5. Receptor: [Chrome-plated brass or stainless-steel] [Plastic] bowl.
   6. Drain Piping: [NPS 1-1/4 (DN 32) minimum, chrome-plated brass, receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2/CSA B125.2] [Include galvanized-steel indirect connection to drainage system].
   7. Mounting: Offset pedestal.
   8. Special Construction: Comply with ICC/ANSI A117.1.

2.3 EYE/FACE WASH EQUIPMENT

A. Standard, Freestanding, Plumbed, Eye/Face Wash Units, <Insert drawing designation>:
   1. Capacity: Not less than 3.0 gpm (11.4 L/min.) for at least 15 minutes.
   2. Supply Piping: NPS 1/2 (DN 15) chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
   3. Control-Valve Actuator: [Paddle] [Treadle] <Insert actuator>.
   4. Spray-Head Assembly: Two or four receptor-mounted spray heads.
   5. Receptor: [Chrome-plated brass or stainless-steel] [Plastic] bowl.
   6. Drain Piping: [NPS 1-1/4 (DN 32) minimum, chrome-plated brass, receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2/CSA B125.2] [Include galvanized-steel indirect connection to drainage system].
   7. Mounting: Pedestal.

B. Accessible, Freestanding, Plumbed, Eye/Face Wash Units, <Insert drawing designation>:
   1. Capacity: Not less than 3 gpm (11.4 L/min.) for at least 15 minutes.
   2. Supply Piping: NPS 1/2 (DN 15) chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
   3. Control-Valve Actuator: [Paddle] <Insert actuator>.
   4. Spray-Head Assembly: Two or four receptor-mounted spray heads.
   5. Receptor: [Chrome-plated brass or stainless-steel] [Plastic] bowl.
   6. Drain Piping: [NPS 1-1/4 (DN 32) minimum, chrome-plated brass, receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2/CSA B125.2] [Include galvanized-steel indirect connection to drainage system].
   7. Mounting: Offset pedestal.
   8. Special Construction: Comply with ICC/ANSI A117.1.

2.4 COMBINATION UNITS

A. Standard, Plumbed Emergency Shower with Eyewash Combination Units, <Insert drawing designation>:
   1. Piping:
      a. Material: [Galvanized steel] [Chrome-plated brass or stainless steel] [PVC].
      b. Unit Supply: [NPS 1-1/4 (DN 32) minimum] [NPS 1-1/2 (DN 40)].
      c. Unit Drain: Outlet at back or side near bottom.
   2. Shower:
      a. Capacity: Not less than 20 gpm (76 L/min.) for at least 15 minutes.
      b. Supply Piping: NPS 1 (DN 25) with flow regulator and stay-open control valve.
      c. Control-Valve Actuator: [Pull rod] [Treadle] <Insert actuator>.
      d. Shower Head: 8-inch- (200-mm-) minimum diameter, [chrome-plated brass or stainless steel] [plastic].
      e. Mounting: Pedestal.
   3. Eyewash Unit:
      a. Capacity: Not less than 0.4 gpm (1.5 L/min.) for at least 15 minutes.
      b. Supply Piping: NPS 1/2 (DN 15) with flow regulator and stay-open control valve.

c. Control-Valve Actuator: Paddle.
d. Spray-Head Assembly: Two receptor-mounted spray heads.
e. Receptor: [Chrome-plated brass or stainless-steel] [Plastic] bowl.
f. Mounting: Attached shower pedestal.
g. Drench-Hose Option: May be provided instead of eyewash unit.

1) Capacity: Not less than 0.4 gpm (1.5 L/min.) for at least 15 minutes.
2) Drench Hose: Hand-held spray head with squeeze-handle actuator and hose.
3) Mounting: Bracket on shower pedestal.

B. Accessible, Plumbed Emergency Shower with Eyewash Combination Units, <Insert drawing designation>:

1. Piping:

a. Material: [Galvanized steel] [Chrome-plated brass or stainless steel] [PVC].
b. Unit Supply: [NPS 1-1/4 (DN 32) minimum] [NPS 1-1/2 (DN 40)].
c. Unit Drain: Outlet at back or side near bottom.

2. Shower:

a. Capacity: Not less than 20 gpm (76 L/min.) for at least 15 minutes.
b. Supply Piping: NPS 1 (DN 25) with flow regulator and stay-open control valve.
c. Control-Valve Actuator: [Pull rod] <Insert actuator>.
d. Shower Head: 8-inch- (200-mm-) minimum diameter, [chrome-plated brass or stainless steel] [plastic].
e. Mounting: Pedestal.

3. Eyewash Unit:

a. Capacity: Not less than 0.4 gpm (1.5 L/min.) for at least 15 minutes.
b. Supply Piping: NPS 1/2 (DN 15) with flow regulator and stay-open control valve.
c. Control-Valve Actuator: Paddle.
d. Spray-Head Assembly: Two receptor-mounted spray heads.
e. Receptor: [Chrome-plated brass or stainless-steel] [Plastic] bowl.
f. Mounting: Attached shower pedestal.
g. Drench-Hose Option: May be provided instead of eyewash unit.

1) Capacity: Not less than 0.4 gpm (1.5 L/min.) for at least 15 minutes.
2) Drench Hose: Hand-held spray head with squeeze-handle actuator and hose.
3) Mounting: Bracket on shower pedestal.

C. Standard, Plumbed Emergency Shower with Eye/Face Wash Combination Units, <Insert drawing designation>:

1. Piping:

a. Material: [Galvanized steel] [Chrome-plated brass or stainless steel] [PVC].
b. Unit Supply: [NPS 1-1/4 (DN 32) minimum] [NPS 1-1/2 (DN 40)].
c. Unit Drain: Outlet at back or side near bottom.

2. Shower:

a. Capacity: Not less than 20 gpm (76 L/min.) for at least 15 minutes.
b. Supply Piping: NPS 1 (DN 25) with flow regulator and stay-open control valve.
c. Control-Valve Actuator: [Pull rod] [Treadle] <Insert actuator>.
d. Shower Head: 8-inch- (200-mm-) minimum diameter, [chrome-plated brass or stainless steel] [plastic].
e. Mounting: Pedestal.

3. Eye/Face Wash Unit:

a. Capacity: Not less than 3 gpm (11.4 L/min.) for at least 15 minutes.
b. Supply Piping: NPS 1/2 (DN 15) with flow regulator and stay-open control valve.
c. Control-Valve Actuator: Paddle.
d. Spray-Head Assembly: Two or four receptor-mounted spray heads.
e. Receptor: [Chrome-plated brass or stainless-steel] [Plastic] bowl.
f. Mounting: Attached shower pedestal.
g. Drench-Hose Option: May be provided instead of eye/face wash unit.

1) Capacity: Not less than 3 gpm (11.4 L/min.) for at least 15 minutes.
2) Drench Hose: Hand-held spray head with squeeze-handle actuator and hose.
3) Mounting: Bracket on shower pedestal.

D. Accessible, Plumbed Emergency Shower with Eye/Face Wash Combination Units, <Insert drawing designation>:

1. Piping:

a. Material: [Galvanized steel] [Chrome-plated brass or stainless steel] [PVC].
b. Unit Supply: [NPS 1-1/4 (DN 32) minimum] [NPS 1-1/2 (DN 40)].
c. Unit Drain: Outlet at back or side near bottom.

2. Shower:

a. Capacity: Not less than 20 gpm (76 L/min.) for at least 15 minutes.
b. Supply Piping: NPS 1 (DN 25) with flow regulator and stay-open control valve.
c. Control-Valve Actuator: [Pull rod] <Insert actuator>.
d. Shower Head: 8-inch- (200-mm-) minimum diameter, [chrome-plated brass or stainless steel] [plastic].
e. Mounting: Pedestal.

3. Eye/Face Wash Unit:

a. Capacity: Not less than 3 gpm (11.4 L/min.) for at least 15 minutes.
b. Supply Piping: NPS 1/2 (DN 15) with flow regulator and stay-open control valve.
c. Control-Valve Actuator: Paddle.
d. Spray-Head Assembly: Two or four receptor-mounted spray heads.
e. Receptor: [Chrome-plated brass or stainless-steel] [Plastic] bowl.
f. Mounting: Attached to shower pedestal.
g. Drench-Hose Option: May be provided instead of eye/face wash unit.

1) Capacity: Not less than 3 gpm (11.4 L/min.) for at least 15 minutes.
2) Drench Hose: Hand-held spray head with squeeze-handle actuator and hose.
3) Mounting: Bracket on shower pedestal.

E. Freeze-Protected, Plumbed Emergency Shower with Eyewash Combination Units, <Insert drawing designation>:
   1. Piping: Galvanized steel.
      a. Unit Supply: [NPS 1-1/4 (DN 32) minimum] [NPS 1-1/2 (DN 40)] from bottom.
   2. Heating System: Electric, [120] [240]-V ac; and insulation with protective jacket and thermometer.
      a. Heating Capacity: [10 deg F (6 deg C)] <Insert temperature> minimum above ambient temperature.
      b. Design Ambient Temperature: <Insert temperature>.
   3. Shower:
      a. Shower Capacity: Not less than 20 gpm (76 L/min.) for at least 15 minutes.
      b. Supply Piping: NPS 1 (DN 25) with flow regulator and stay-open control valve.
      c. Control-Valve Actuator: [Pull rod] <Insert actuator>.
      d. Shower Head: 8-inch- (200-mm-) minimum diameter, [chrome-plated brass or stainless steel] [plastic].
      e. Mounting: Pedestal.
   4. Eyewash Unit:
      a. Capacity: Not less than 0.4 gpm (1.5 L/min.) for at least 15 minutes.
      b. Supply Piping: NPS 1/2 (DN 15) with flow regulator and stay-open control valve.
      c. Control-Valve Actuator: [Paddle] <Insert actuator>.
   5. Eye/Face Wash Unit:
      a. Capacity: Not less than 3 gpm (11.4 L/min.) for at least 15 minutes.
      b. Control-Valve Actuator: [Paddle] <Insert actuator>.
   6. Appurtenances:
      a. <Insert appurtenances>.

2.5 WATER-TEMPERING EQUIPMENT

A. Hot- and Cold-Water, Water-Tempering Equipment, <Insert drawing designation>:
   1. Description: Factory-fabricated equipment with thermostatic mixing valve.
      a. Thermostatic Mixing Valve: Designed to provide [85 deg F (29 deg C)] <Insert temperature> tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus [5 deg F (3 deg C)] <Insert temperature> throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, metal piping, and corrosion-resistant enclosure.
      b. Supply Connections: For hot and cold water.

2.6 SOURCE QUALITY CONTROL

A. Certify performance of emergency plumbing fixtures by independent testing organization acceptable to authorities having jurisdiction.

1. Exception: <Insert manufacturer's name>.

PART 3 - EXECUTION

3.1 EMERGENCY PLUMBING FIXTURE INSTALLATION

A. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.

B. Install fixtures level and plumb.

C. Fasten fixtures to substrate.

D. Install shutoff valves in water-supply piping to fixtures. Use ball or gate valve if specific type valve is not indicated. Install valves chained or locked in open position if permitted. Install valves in locations where they can easily be reached for operation. Comply with requirements for valves specified in Section 220523.12 "Ball Valves for Plumbing Piping" and Section 220523.15 "Gate Valves for Plumbing Piping."

1. Exception: Omit shutoff valve on supply to group of plumbing fixtures that includes emergency equipment.
2. Exception: Omit shutoff valve on supply to emergency equipment if prohibited by authorities having jurisdiction.

E. Install shutoff valve and strainer in steam piping and shutoff valve in condensate return piping. Comply with requirements for steam and condensate piping specified in Section 232213 "Steam and Condensate Heating Piping" and Section 232216 "Steam and Condensate Piping Specialties."

F. Install dielectric fitting in supply piping to emergency equipment if piping and equipment connections are made of different metals. Comply with requirements for dielectric fittings specified in Section 221116 "Domestic Water Piping."

G. Install thermometers in supply and outlet piping connections to water-tempering equipment. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."

H. Install trap and waste piping on drain outlet of emergency equipment receptors that are indicated to be directly connected to drainage system. Comply with requirements for waste piping specified in Section 221316 "Sanitary Waste and Vent Piping."

I. Install indirect waste piping on drain outlet of emergency equipment receptors that are indicated to be indirectly connected to drainage system. Comply with requirements for waste piping specified in Section 221316 "Sanitary Waste and Vent Piping."

J. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

K. Fill self-contained fixtures with flushing fluid.

3.2 CONNECTIONS

A. Connect cold-water-supply piping to plumbed emergency plumbing fixtures not having water-tempering equipment. Comply with requirements for cold-water piping specified in Section 221116 "Domestic Water Piping."

B. Connect hot- and cold-water-supply piping to hot- and cold-water, water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures. Comply with requirements for hot- and cold-water piping specified in Section 221116 "Domestic Water Piping."

C. Connect steam and cold-water-supply and condensate return piping to steam and cold water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures. Comply with requirements for cold-water piping specified in Section 221116 "Domestic Water Piping" and comply with requirements for steam and condensate piping specified in Section 232213 "Steam and Condensate Heating Piping" and Section 232216 "Steam and Condensate Piping Specialties."

D. Connect cold water and electrical power to electric heating water-tempering equipment. Comply with requirements for cold-water piping specified in Section 221116 "Domestic Water Piping."

E. Directly connect emergency plumbing fixture receptors with trapped drain outlet to sanitary waste and vent piping. Comply with requirements for waste piping specified in Section 221316 "Sanitary Waste and Vent Piping."

F. Indirectly connect emergency plumbing fixture receptors without trapped drain outlet to sanitary waste or storm drainage piping.

G. Where installing piping adjacent to emergency plumbing fixtures, allow space for service and maintenance of fixtures.

3.3 IDENTIFICATION

A. Install equipment nameplates or equipment markers on emergency plumbing fixtures and equipment and equipment signs on water-tempering equipment. Comply with requirements for identification materials specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Emergency plumbing fixtures[and water-tempering equipment] will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust or replace fixture flow regulators for proper flow.

B. Adjust equipment temperature settings.

END OF SECTION

SPECIFICATION REVISION INDEX

Revision No.	Revision Date	Issued for	Signatures				
			Prepared By	Reviewed By	Project Engineer	Project Manager	Client
A	11/28/2016	60% Submittal	CMF	JG	JG	STD	
B	2/15/2017	75% Submittal	CMF	JG	JG	STD	

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SECTION 15470

HEAT TRACING FOR PROCESS PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Self-regulating cables.
   2. Heat-tracing controls.

1.2 DEFINITIONS

A. Self-Regulating Index (SRI): The rate of change of power output in Watts per degree F (Watts per degree C), as measured between the temperatures of 50 degrees F (10 degrees C) and 100 degrees F (38 degrees C).

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's product data for system materials and component equipment, including thermal properties, electrical characteristics, and connection requirements.

B. Shop Drawings:
   1. Indicate system materials and component equipment.
   2. Submit wiring and control diagrams, installation and anchoring requirements, fasteners, and other details.

C. Manufacturer's Certificate: Certify that [products] <_____> meet or exceed [specified requirements] <_____>.
   1. Certify installation is completed according to manufacturer's instructions.

D. Manufacturer's Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

E. Source Quality-Control Submittals: Indicate results of [shop] [factory] tests and inspections.

F. Field Quality-Control Submittals: Indicate results of General Contractor-furnished tests and inspections.

G. Manufacturer Reports: Indicate that equipment has been installed according to manufacturer's instructions.

H. Qualifications Statement:
   1. Submit qualifications for manufacturer.

1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of piping receiving heat tracing and locations of source power and controls.

B. Operation and Maintenance Data: Submit maintenance instructions for equipment and accessories.

1.5 QUALITY ASSURANCE

A. Perform Work according to <_____> standards.

B. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum [three] <_____> years' [documented] experience.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in manufacturer's packaging, including application instructions.

B. Accept heat tracing on-Site in original packaging. Inspect for damage.

C. Store heat tracing and components according to manufacturer's instructions.

D. Protect heat tracing from water and wet weather.

1.7 EXISTING CONDITIONS

A. Field Measurements: Verify field measurements prior to fabrication. Indicate field measurements on Shop Drawings.

1.8 WARRANTY

A. Furnish [five] [10] <_____>-year manufacturer's warranty for heat tracing and components.

PART 2 PRODUCTS

2.1 SELF-REGULATING CABLE

A. Manufacturers:
   1. <Click link above to find, evaluate, and insert list of manufacturers from SpecAgent>.
   2. Substitutions: [Permitted] [Not permitted].

****** [OR] ******

   3. Furnish materials according to <_____> standards.

B. Description:
   1. Bus Wires: Two, parallel; nickel-coated copper; minimum size 16 AWG.
   2. Heating Element: Self-regulating polymeric core.

3. Jacketing:
    a. Tinned copper braid with resistance less than cable bus wire resistance, as determined by ASTM B193.
    b. [Polyolefin] [Fluoropolymer] insulating jacket.
4. Cable Temperature Identification Number (T-Rating): T6, without use of thermostats; according to NEC.
5. Output: As indicated.

C. Performance and Design Criteria:
1. Power output varies relative to the temperature of surface of pipe or appurtenance.
2. Cable can be crossed over itself and cut to length at Site.
3. Minimum SRI:

CABLE RATING	SRI (W PER DEGREE F)	SRI (W PER DEGREE C)
<_____> W/ft. (<_____> W/m)	<_____>	<_____>
<_____> W/ft. (<_____> W/m)	<_____>	<_____>
<_____> W/ft. (<_____> W/m)	<_____>	<_____>
<_____> W/ft. (<_____> W/m)	<_____>	<_____>

D. Operation:
1. Electrical Characteristics: According to Section 26 05 03 - Equipment Wiring Connections and following:
    a. <_____> rated load amperes.
    b. Voltage: <_____> V, [single] [three] phase, 60 Hz.
    c. Maximum [Fuse Size] [Circuit Breaker Size] [Overcurrent Protection]: <_____> A.
    d. Minimum Circuit Ampacity: <_____>.
    e. Furnish ground-fault protection device set at 30 mA, with nominal 100-ms response time, to protect each circuit.
2. Disconnect Switch: Factory mounted in control panel.

E. Accessories:
1. Approved for the respective area classification and approved as a system with the particular type of heating cable in use.
2. Splicing connectors.
3. End terminations.
4. T-connectors.
5. Power termination kits.

2.2 HEAT-TRACING CONTROLS

A. Control and Monitoring Panel:
1. Materials: Nonmetallic.
2. Rating: NEMA 4X.
3. Configuration: [Wall mounted] [Pedestal mounted] <_____>.
4. Temperature Controller: Microprocessor based; diagnostic self-testing capability.
5. Communications Port: Modbus ASCII via RS 485.
6. ON-OFF Control: Soft start.
7. Real-Time Data Indication:
    a. Temperature.
    b. Heater current.

c. Ground leakage current.
8. Stored Data:
   a. Highest temperature encountered.
   b. Lowest temperature encountered.
9. Alarms: <_____>.

B. Single Thermostat:
1. Description: Stainless-steel remote bulb with <_____>-foot (<_____>-m) capillary encased in flexible stainless-steel armor.
2. Housing: FM-approved, NEMA 4X.
3. Set-Point Range: <____> to <____> degrees F (<____> to <____> degrees C).

****** [OR] ******

C. Explosionproof Thermostat:
1. Description: <_____>-foot (<_____>-m) capillary bulb encased in armored sheathing.
2. Housing: Cast aluminum, conforming to requirements for Class 1; Divisions 1 and 2; Groups B, C, and D areas.
3. Set-Point Range: <____> to <____> degrees F (<____> to <____> degrees C).

2.3 SOURCE QUALITY CONTROL

A. Testing:
1. Conform to IEC 216-1 for following:
   a. Retain at least 75 percent of rated power after 20 years of operation at maximum published continuous exposure (maintain) temperature.
   b. Retain at least 90 percent of rated power after 1,000 hours of operation at maximum published intermittent exposure temperature.
2. Cable Dielectric Test: Passing 2.5 kV dielectric test for one minute according to ASTM D2633 after undergoing a 0.5 kg-m impact according to IEC 60800.
3. Before shipment, demonstrate cable insulation resistance of 20 megohms minimum bus to braid using a 2,500-V DC megger, and demonstrate tolerance for one minute at voltage equal to twice rated plus 1,000 V applied bus to braid.
4. Thermal Runaway:
   a. Ensure that cable produces less than <_____> W/ft. (<_____> W/m) when energized and heated to <_____> degrees F (<_____> degrees C) for 30 minutes.
   b. After testing and reenergizing, demonstrate that cable does not have an increasing power output leading to thermal runaway.

B. Certificate of Compliance: When fabricator is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at fabricator's facility conforms to Contract Documents.
1. Specified shop tests are not required for Work performed by approved fabricator.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that surfaces of pipes, valves, and fittings are clean and dry.

B. Verify that piping has been inspected and is ready for insulation.

3.2 INSTALLATION

A. Install heat tracing before insulation is installed.

B. Install equipment according to manufacturer's instructions.

C. If required, spiral heat-trace cable around piping to obtain proper heating per length of piping.

D. Do not overlay cable over cable.

E. Cover installed heating cable with thermal insulation and waterproof jacketing as soon as possible.

F. Affix following label, as specified in Section 40 05 53 - Identification for Process Piping, to exterior of thermal insulation every <_____> feet (<_____> m) and readily visible from ground level: ELECTRIC HEAT TRACING: CAUTION.

****** [OR] ******

G. Installation Standards: Install Work according to <_____> standards.

3.3 FIELD QUALITY CONTROL

A. After installation, inspect for proper operation.

B. Manufacturer Services: Furnish services of manufacturer's representative experienced in installation of products furnished under this Section for not less than <_____> days on-Site for installation, inspection, field testing, and instructing Owner's personnel in maintenance of equipment.

3.4 ADJUSTING

A. Adjust <_____>. Check control module functions.

B. Check thermostat and wiring connections to heater cable.

3.5 DEMONSTRATION

A. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION

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SPECIFICATION REVISION INDEX

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			Prepared By	Reviewed By	Project Engineer	Project Manager	Client
A	11/18/2016	60% Submittal	CMF	JG	JG	STD	
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SECTION 15478

HEAT TRACING FOR PLUMBING PIPING

PART 1 GENERAL

1.01 SUMMARY:

A. Section includes plumbing piping heat tracing for freeze prevention and domestic hot-water-temperature maintenance with the following electric heating cables:

1. Self-regulating, parallel resistance.

1.02 ACTION SUBMITTALS:

A. Product Data: For each type of product.

B. Shop Drawings: For electric heating cable.

1.03 INFORMATIONAL SUBMITTALS:

A. Field quality-control reports.

B. Sample Warranty: For special warranty.

1.04 CLOSEOUT SUBMITTALS:

A. Operation and maintenance data.

1.05 QUALITY ASSURANCE:

A. Manufacturer Qualifications: Ten (10) years' experience in design, Engineering, manufacture and support of specified system and components.

1.06 WARRANTY:

A. Special Warranty: Manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.

1. Warranty Period: Ten (10) years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES:

A. Comply with IEEE 515.1.

B. Heating Element: Pair of parallel No. 16 AWG, nickel-coated, stranded copper bus wires embedded in cross-linked conductive polymer core, which varies heat output in response to temperature along its length. Terminate with waterproof, factory-assembled, non-heating leads with connectors at one end, and seal the opposite end watertight. Cable shall be capable of crossing over itself once without overheating.

C. Electrical Insulating Jacket: Flame-retardant polyolefin.

D. Cable Cover: Tinned-copper braid and polyolefin outer jacket with ultraviolet inhibitor.

E. Maximum Operating Temperature (Power On): 150 deg F.

F. Maximum Exposure Temperature (Power Off): 185 deg F.

G. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

H. Capacities and Characteristics:

1. Maximum Heat Output: 8 W/ft.
2. Piping Diameter: As indicated on drawings.
3. Electrical Characteristics for Single-Circuit Connection: 120 volts, single phase, 60 Hz.

2.02 CONTROLS:

A. Pipe-Mounted Thermostats for Freeze Protection:

1. Remote bulb unit with adjustable temperature range from 40 to 100 deg F.
2. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected cable.
3. Remote bulb on capillary, resistance temperature device, or thermistor for directly sensing pipe-wall temperature.
4. Corrosion-resistant, waterproof control enclosure.

2.03 ACCESSORIES:

A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.

Warning Labels: Refer to Section 15075 – Identification for Plumbing Piping and Equipment

B. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.

1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.

2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

PART 3 EXECUTION

3.01 INSTALLATION:

A. Install electric heating cable across expansion, construction, and control joints according to manufacturer's written instructions; use cable-protection conduit and slack cable to allow movement without damage to cable.

B. Electric Heating-Cable Installation for Freeze Protection for Piping:

1. Install electric heating cables after piping has been tested and before insulation is installed.

2. Install electric heating cables according to IEEE 515.1.

3. Install insulation over piping with electric cables according to Section 15080 – Mechanical Insulation.

4. Install warning tape on piping insulation where piping is equipped with electric heating cables.

C. Electric Heating-Cable Installation for Temperature Maintenance for Domestic Hot Water:

1. Install electric heating cables after piping has been tested and before insulation is installed.

2. Install insulation over piping with electric heating cables according to Section 15080 – Mechanical Insulation.

3. Install warning tape on piping insulation where piping is equipped with electric heating cables.

D. Set field-adjustable switches and circuit-breaker trip ranges.

E. Ground equipment according to Section 16060 – Grounding.

F. Connect wiring according to Section 16120 – Wires and Cables (1000 Volt Maximum).

3.02 FIELD QUALITY CONTROL:

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.

2. Test cables for electrical continuity and insulation integrity before energizing.

3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

B. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.

C. Cables will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

E. Remove and replace damaged heat-tracing cables with new.

END OF SECTION

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SPECIFICATION REVISION INDEX

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			Prepared By	Reviewed By	Project Engineer	Project Manager	Client
A	11/28/2016	60% Submittal	CMF	JG	JG	STD	
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SECTION 15910

CONTROL VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes control valves and electric actuators.

B. Related Requirements:

1. Section 230923 "Direct-Digital Control System for HVAC" control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.
2. Section 230933 "Electric and Electronic Control System for HVAC" for electric/electronic control valves and actuators in electric and electronic control systems.
3. Section 230943 "Pneumatic Control System for HVAC" for pneumatic control valves and actuators in pneumatic control systems.
4. Section 230993 "Sequence of Operations for HVAC Controls" for requirements that relate to Section 230923.11.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Include diagrams for power, signal, and control wiring.
2. Include diagrams for pneumatic signal and main air tubing.

C. Delegated-Design Submittal:

1. Schedule and design calculations for control valves and actuators, including the following:

a. Flow at project design and minimum flow conditions.

b. Pressure differential drop across valve at project design flow condition.
c. Maximum system pressure differential drop (pump close-off pressure) across valve at project minimum flow condition.
d. Design and minimum control valve coefficient with corresponding valve position.
e. Maximum close-off pressure.
f. Leakage flow at maximum system pressure differential.
g. Torque required at worst case condition for sizing actuator.
h. Actuator selection indicating torque provided.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASME Compliance: Fabricate and label products to comply with ASME Boiler and Pressure Vessel Code where required by authorities having jurisdiction.

C. Delegated Design: Engage a qualified Professional Engineer as defined in Section 01400 "Quality Control," to size products where indicated as delegated design.

D. Ground Fault: Products shall not fail due to ground fault condition when suitably grounded.

E. Determine control valve sizes and flow coefficients by ISA 75.01.01.

F. Control valve characteristics and rangeability shall comply with ISA 75.11.01.

G. Selection Criteria:

1. Minimum Cv shall be calculated at 10 percent of design flow, with a coincident pressure differential equal to the system design pump head.
2. In water systems, select modulating control valves at terminal equipment for a design Cv based on a pressure drop of 5 psig at design flow unless otherwise indicated.
3. Modulating valve sizes for steam service shall provide a pressure drop at design flow equal to lesser of the following:

a. [50] <Insert number> percent of the valve inlet pressure.
b. [50] <Insert number> percent of the absolute steam pressure at the valve inlet.

2.2 BUTTERFLY-STYLE CONTROL VALVES

A. Commercial-Grade, Two-Way Butterfly Valves:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Performance:

   a. Bi-directional bubble tight shutoff at 250 psig (1724 kPa).
   b. Comply with MSS SP-67 or MSS SP-68.
   c. Rotation: Zero to 90 degrees.
   d. Linear or modified equal percentage flow characteristic.

3. Body: Carbon Steel
4. Disc: 316 stainless steel.
5. Shaft: 316 stainless steel.
6. Seat: Reinforced EPDM or reinforced PTFE with retaining ring.
7. Shaft Bushings: Reinforced PTFE or stainless steel.
8. Replaceable seat, disc, and shaft bushings.
9. Corrosion-resistant nameplate indicating:

   a. Manufacturer's name, model number, and serial number.
   b. Body size.
   c. Body and trim materials.
   d. Flow arrow.

B.

C. Commercial-Grade, Three-Way Butterfly Valves:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Arrangement: Two valves mated to a fabricated tee with interconnecting mechanical linkage.
3. Performance:

   a. Bi-directional bubble tight shutoff at 250 psig (1724 kPa).
   b. Comply with MSS SP-67 or MSS SP-68.
   c. Rotation: Zero to 90 degrees.
   d. Linear or modified equal percentage flow characteristic.

4. Body: Cast iron ASTM A 126, Class B, ductile iron ASTM A 536 or cast steel ASTM A 216/A 216M WCB fully lugged, suitable for mating to ASME B16.5 flanges.
5. Disc: 316 stainless steel.
6. Shaft: 316 or 17-4 PH stainless steel.
7. Seat: Reinforced EPDM or reinforced PTFE seat with retaining ring.
8. Shaft Bushings: Reinforced PTFE or stainless steel.
9. Replaceable seat, disc, and shaft bushings.
10. Corrosion-resistant nameplate indicating:

    a. Manufacturer's name, model number, and serial number.

b. Body size.
c. Body and trim materials.
d. Flow arrow.

2.3 PRESSURE REGULATING VALVE

A. Description:

1. The Pressure Reducing Valve shall maintain a constant downstream pressure regardless of changing flow rate and/or inlet pressure. Pressure reducing valve that can reduce pressure regardless of varying flow rate and/or inlet pressure
2. The valve shall be hydraulically operated, single diaphragm-actuated, globe or angle pattern. The valve shall consist of three major components: the body, with seat installed; the cover, with bearings installed; and the diaphragm assembly. The diaphragm shall be the only moving part and shall form a sealed chamber in the upper portion of the valve, separating operating pressure from line pressure.
3. Packing glands and/or stuffing boxes are not permitted and there shall be no pistons operating the main valve or pilot controls.
4. The diaphragm must withstand a Mullins Burst Test of a minimum of 600 psi per layer of nylon fabric and shall be cycle tested 100,000 times to ensure longevity. Bellofram type rolling diaphragms shall not be permitted.

B. Construction:
1. Valve Body: Ductile Iron
2. Trim and Seats: Stainless steel.
3. Disc: Buna-N.
4. Diaphragm: Buna-N
5. Disc retainer and diaphragm washer: Cast Iron.
6. Stem, Nut and spring: Stainless Steel.
7. Pressure adjustment ranges: 30 to 300 psi.

2.4 ELECTRIC CONTROL VALVE ACTUATORS

A. Actuators for Hydronic Control Valves: Capable of closing valve against system pump shutoff head.

B. Position indicator and graduated scale on each actuator.

C. Type: Motor operated, with or without gears, electric.

D. Voltage: 480V 3-phase

E. Deliver torque required for continuous uniform movement of controlled device from limit to limit when operated at rated voltage.

F. Function properly within a range of 85 to 120 percent of nameplate voltage.

G. Construction:

1. For Actuators Less Than 100 W: Fiber or reinforced nylon gears with steel shaft, copper alloy or nylon bearings, and pressed steel enclosures.
2. For Actuators from 100 to 400 W: Gears ground steel, oil immersed, shaft hardened steel running in bronze, copper alloy or ball bearings. Operator and gear trains shall be totally enclosed in dustproof cast-iron, cast-steel or cast-aluminum housing.
3. For Actuators Larger Than 400 W: Totally enclosed reversible induction motors with auxiliary hand crank and permanently lubricated bearings.

H. Field Adjustment:

1. Spring Return Actuators: Easily switchable from fail open to fail closed in the field without replacement.
2. Gear Type Actuators: External manual adjustment mechanism to allow manual positioning when the actuator is not powered.

I. Two-Position Actuators: Single direction, spring return or reversing type.

J. Modulating Actuators:

1. Operation: Capable of stopping at all points across full range, and starting in either direction from any point in range.
2. Control Input Signal:

    a. Three Point, Tristate, or Floating Point: Clockwise and counter-clockwise inputs. One input drives actuator to open position and other input drives actuator to close position. No signal of either input remains in last position.
    b. Proportional: Actuator drives proportional to input signal and modulates throughout its angle of rotation. Suitable for [zero- to 10-] [or] [2- to 10-]V dc [and] [4- to 20-mA] signals.
    c. Pulse Width Modulation (PWM): Actuator drives to a specified position according to pulse duration (length) of signal from a dry contact closure, triac sink, or source controller.
    d. Programmable Multi-Function:

        1) Control Input, Position Feedback, and Running Time: Factory or field programmable.
        2) Diagnostic: Feedback of hunting or oscillation, mechanical overload, mechanical travel, and mechanical load limit.
        3) Service Data: Include, at a minimum, number of hours powered and number of hours in motion.

K. Position Feedback:

1. [Equip] [Where indicated, equip] two-position actuators with limits switches or other positive means of a position indication signal for remote monitoring of [open] [and] [close] position.
2. [Equip] [Where indicated, equip] modulating actuators with a position feedback through [current] [or] [voltage] signal for remote monitoring.
3. Provide a position indicator and graduated scale on each actuator indicating open and closed travel limits.

L. Fail-Safe:

1. Where indicated, provide actuator to fail to an end position.
2. Internal spring return mechanism to drive controlled device to an end position (open or close) on loss of power.
3. Batteries, capacitors, and other non-mechanical forms of fail-safe operation are acceptable only where uniquely indicated.

M. Integral Overload Protection:

1. Provide against overload throughout the entire operating range in both directions.
2. Electronic overload, digital rotation sensing circuitry, mechanical end switches, or magnetic clutches are acceptable methods of protection.

N. Valve Attachment:

1. Unless otherwise required for valve interface, provide an actuator designed to be directly coupled to valve shaft without the need for connecting linkages.
2. Attach actuator to valve drive shaft in a way that ensures maximum transfer of power and torque without slippage.
3. Bolt and set screw method of attachment is acceptable only if provided with at least two points of attachment.

O. Temperature and Humidity:

1. Temperature: Suitable for operating temperature range encountered by application with minimum operating temperature range of [minus 20 to plus 120 deg F (minus 29 to plus 49 deg C)] <Insert temperature range>.
2. Humidity: Suitable for humidity range encountered by application; minimum operating range shall be from [5 to 95] <Insert number(s)> percent relative humidity, non-condensing.

P. Enclosure:

1. Suitable for ambient conditions encountered by application.
2. NEMA 250, Type 2 for indoor and protected applications.
3. NEMA 250, Type 4 or Type 4X or Type 6P for outdoor and unprotected applications.
4. Provide actuator enclosure with heater and control where required by application.

Q. Stroke Time:

1. Operate valve from fully closed to fully open within [15] [60] [75] [90] [150] <Insert number> seconds.
2. Operate valve from fully open to fully closed within [15] [60] [75] [90] [150] <Insert number> seconds.
3. Move valve to failed position within [5] [15] [30] <Insert number> seconds.
4. Select operating speed to be compatible with equipment and system operation.

R. Sound:

1. Spring Return: <70 dBA.

2. Non-Spring Return: <70 dBA.

PART 3 - EXECUTION

3.1 CONTROL VALVE APPLICATIONS

A. Control Valves:

1. Select from valves specified in "Control Valves" Article to achieve performance requirements and characteristics indicated while subjected to full range of system operation encountered.
2. Butterfly-style valves, commercial-grade, two-way valves system controlled by Flow.
3. <Insert system> System, <Insert unique application>, Two-Way Applications Controlled by Pressure: [Ball valves with single port and characterized disk] [Pressure-independent ball valves] [Butterfly-style valves, commercial-grade, two-way valves] [Globe-style, two-way valves].
4. <Insert system> System, <Insert unique application>, Two-Way Applications Controlled by Temperature: [Ball valves with single port and characterized disk] [Pressure-independent ball valves] [Butterfly-style valves, commercial-grade, two-way valves] [Globe-style, two-way valves] [Solenoid valves].
5. <Insert system> System, <Insert unique application>, Three Way, Controlled by Temperature: [Ball valves with two ports and characterized disk] [Butterfly-style valves, commercial-grade, three-way valves] [Globe-style, three-way valves].

3.2 INSTALLATION, GENERAL

A. Furnish and install products required to satisfy most stringent requirements indicated.

B. Install products level, plumb, parallel, and perpendicular with building construction.

C. Properly support instruments, tubing, piping, wiring, and conduits to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to a <Insert value> force.

D. Provide ceiling, floor, roof, and wall openings and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.

E. Firestop penetrations made in fire-rated assemblies and seal penetrations made in acoustically rated assemblies.

F. Fastening Hardware:

1. Stillson wrenches, pliers, and other tools that will cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for assembling and tightening nuts.
2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.

3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

G. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

H. Corrosive Environments:

1. Use products that are suitable for environment to which they will be subjected.
2. If possible, avoid or limit use of materials in corrosive environments, including. but not limited to, the following:

    a. Laboratory exhaust airstreams.
    b. Process exhaust airstreams.

3. Use Type 316 stainless-steel tubing and fittings when in contact with a corrosive environment.
4. When conduit is in contact with a corrosive environment, use Type 316 stainless-steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment.
5. Where control devices are located in a corrosive environment and are not corrosive resistant from manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

3.3 ELECTRIC POWER

A. Furnish and install electrical power to products requiring electrical connections.

B. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."

C. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

D. Furnish and install raceways. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."

3.4 CONTROL VALVES

A. Install pipe reducers for valves smaller than line size. Position reducers as close to valve as possible but at distance to avoid interference and impact to performance. Install with manufacturer-recommended clearance.

B. Install flanges or unions to allow drop-in and -out valve installation.

C. Where indicated, install control valve with three-valve bypass manifold to allow for control valve isolation and removal without interrupting system flow by providing manual throttling valve in bypass pipe.

1. <Insert applications>.

D. Install drain valves in piping upstream and downstream of each control valve installed in a three-valve manifold and for each control valve larger than [NPS 2 (DN 50)] [NPS 4 (DN 100)] <Insert nominal pipe size>.

E. Install pressure temperature taps in piping upstream and downstream of each control valve larger than [NPS 1 (DN 25)] [NPS 2 (DN 50)] <Insert nominal pipe size>.

F. Valve Orientation:

1. Where possible, install globe and ball valves installed in horizontal piping with stems upright and not more than 15 degrees off of vertical, not inverted.
2. Install valves in a position to allow full stem movement.
3. Where possible, install butterfly valves that are installed in horizontal piping with stems in horizontal position and with low point of disc opening with direction of flow.

G. Clearance:

1. Locate valves for easy access and provide separate support of valves that cannot be handled by service personnel without hoisting mechanism.
2. Install valves with at least 12 inches (300 mm) of clear space around valve and between valves and adjacent surfaces.

H. Threaded Valves:

1. Note internal length of threads in valve ends, and proximity of valve internal seat or wall, to determine how far pipe should be threaded into valve.
2. Align threads at point of assembly.
3. Apply thread compound to external pipe threads, except where dry seal threading is specified.
4. Assemble joint, wrench tight. Apply wrench on valve end as pipe is being threaded.

I. Flanged Valves:

1. Align flange surfaces parallel.
2. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.

J. Connect electrical devices and components to electrical grounding system. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

K. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

L. Install engraved phenolic nameplate with valve identification on valve[and on face of ceiling directly below valves concealed above ceilings].

3.5 CHECKOUT PROCEDURES

A. Control Valve Checkout:

1. Check installed products before continuity tests, leak tests, and calibration.
2. Check valves for proper location and accessibility.
3. Check valves for proper installation for direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.
4. For pneumatic products, verify air supply for each product is properly installed.
5. For pneumatic valves, verify that pressure gauges are provided in each air line to valve actuator and positioner.
6. Verify that control valves are installed correctly for flow direction.
7. Verify that valve body attachment is properly secured and sealed.
8. Verify that valve actuator and linkage attachment are secure.
9. Verify that actuator wiring is complete, enclosed, and connected to correct power source.
10. Verify that valve ball, disc, and plug travel are unobstructed.
11. After piping systems have been tested and put into service, but before insulating and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks. Replace the valve if leaks persist.

3.6 ADJUSTMENT, CALIBRATION, AND TESTING

A. Stroke and adjust control valves following manufacturer's recommended procedure, from 100 percent open to 100 percent closed back to 100 percent open.

B. Stroke control valves with pilot positioners. Adjust valve and positioner following manufacturer's recommended procedure, so valve is 100 percent closed, 50 percent closed, and 100 percent open at proper air pressures.

C. Check and document open and close cycle times for applications with a cycle time of less than 30 seconds.

D. For control valves equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

END OF SECTION

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SPECIFICATION REVISION INDEX

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			Prepared By	Reviewed By	Project Engineer	Project Manager	Client
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SECTION 16050

BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: General administrative, procedural requirements, and installation methods for electrical installations specified in Division 16.

B. The Drawings are schematic and are not intended to show every detail of construction.
   1. In general, conduits/raceways, transitions and offsets shown on Drawings indicate approximate locations in plan and elevation where the systems are intended to be run.
   2. CONSTRUCTION MANAGER shall fully coordinate electrical Work with other trades to avoid interferences.

B. Related Documents: Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Sections, apply to Work of this Section.

1.02 SUBMITTALS

A. Shop Drawings: Submit in accordance with requirements of Shop Drawings covering the items included under this Section of Work. Shop Drawing submittals shall include:
   1. Submit product data covering the items included under this Section of Work.

B. Conforming to Construction Drawings: Submit a complete set of Drawings showing the locations of the piping, conduit runs, poles, devices, equipment, etc., as actually installed. Such Drawings shall be submitted to CONSTRUCTION MANAGER on tracing cloth, mylar, or sepia paper from which blueprints can be obtained.

C. Operation and Maintenance Manuals: Submit , operation and maintenance manuals for items included under this Section. Include following information for equipment items:
   1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
   2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
   3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
   4. Servicing instructions and lubrication charts and schedules.

1.03 RECORD DOCUMENTS

A. Prepare Record Documents.In addition, CONSTRUCTION MANAGER shall submit, prior to final payment, Drawings conforming to construction records of systems it has installed. Vendor drawings shall be sized as manufacturers' standard.

B. Provide typewritten data sheets for panelboards and switchboards and engraved phenolic tags on motor control circuits with following information on each branch feeder: Load name, horsepower or KVA (transformer) rating.

1.04 QUALITY ASSURANCE

A. National Electrical Code: Comply with NFPA 70, National Electrical Code.

B. UL Compliance and Labeling: Use products and components labeled by UL.

1.05 PERMITS, INSPECTIONS, AND LICENSES

A. CONSTRUCTION MANAGER shall procure all necessary permits and licenses, observe and abide by all applicable laws, codes, regulations, ordinances, and rules of the State, territory, or political subdivision thereof, wherein Work is done, or any other duly constituted public authority, and further agrees to hold CONSTRUCTION MANAGER harmless from liability or penalty which might be imposed by reason of an asserted violation of such laws, codes, regulations, ordinances, or other rules.
   1. Upon completion of Work, CONSTRUCTION MANAGER shall secure certificates of inspection from the inspector having jurisdiction and shall submit 3 copies of the certificates to TRUST. CONSTRUCTION MANAGER shall pay the fees for the permits, inspections, licenses, and certifications when such fees are required.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to Project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification. Equipment shall be packaged to prevent damage during shipment, storage, and handling. Do not install damaged units; replace, and remove damaged units from Site.

PART 2 - PRODUCTS

A.

NOT USED

PART 3 - EXECUTION

3.01 GENERAL ELECTRICAL INSTALLATION

A. Provide electrical materials and equipment enclosures appropriate for areas in which they are installed. Each area will be designated on Drawings with a type of construction such as NEMA 4, 4X, 7 or 9 if it is other than NEMA 12. An area designated by a name and elevation includes space bounded by floor, ceiling, and enclosing walls.
   1. Exception: Provide manufacturer's standard construction for indoor or outdoor application where equipment is not manufactured to NEMA specifications (e.g., switchgear, transformers, and light fixtures.

B. Provide nonmetallic, stainless steel or PVC coated rigid steel electrical materials and equipment enclosures in NEMA 4X areas; watertight NEMA 4 and equipment enclosures for outdoor applications and indoor applications below grade; explosion-proof NEC Class I, Division 1, Group D equipment for NEMA 7 areas; explosion-proof NEC Class II, Division 2, Group F equipment for NEMA 9 areas.

C. Provide chases, slots, and openings in other building components during progress of construction, to allow for electrical installations.

D. Supporting devices and sleeves shall be coordinated with other structural components as they are constructed. Share supports with other disciplines wherever possible. No supports shall be installed on liner of retention area without written approval of the means and methods from the CONSTRUCTION MANAGER.

E. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide maximum headroom possible. Locate light fixtures at approximately 8 feet above floor and where fixtures may be readily serviced, refer to details for exteriors pole mount units.

F. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

G. Install systems, materials, and equipment to conform with approved submittal data, including coordination Drawings, to greatest extent possible. Conform to arrangements indicated by Drawings recognizing that portions of Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to CONSTRUCTION MANAGER.

H. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and site piping or structures.

I. As much as practical, connect equipment for ease of disconnecting with minimum of interference with other installations.

J. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope. In addition, refer to mechanical and process piping plans and give preference to those systems when conflicts arise.

3.02 RACEWAY INSTALLATION

A. Outdoors, use the following materials:
   1. Exposed Conduit: Schedule 80 PVC UV stabilized and PVC coated rigid steel conduit and fittings. Utilize PVC coated rigid steel in retention area with threaded connetions; utilize PVC on tank structural support wall and at top of tanks with expansion fittings evey 50 feet.
   2. Underground Direct Buried Conduit: Only allowed on the top of the containment berm for lighting.
   3. Underground Concrete Encased Conduit: Not Allowed
   4. Conduit Used to Connect to Vibrating Equipment including transformers and hydraulic, pneumatic or electric solenoid or motor-driven equipment: Liquidtight flexible metal conduit.

B. Indoors, use the following wiring materials:
   1. Connection to Vibrating Equipment, including transformers and hydraulic, pneumatic or electric solenoid or motor-operated equipment: Liquidtight flexible metal conduit.
   2. Exposed Conduit: Rigid metal conduit or intermediate metal conduit.
      a. Exceptions:
         1) Areas indicated as NEMA 4X, use rigid Schedule 40 PVC conduit.
   3. Concealed Conduit: Rigid metal conduit or intermediate metal conduit unless indicated otherwise.

C. Minimum size conduit shall be 3/4 inch unless shown otherwise.

D. Instrument Signal Conduit Requirements: Shielded signal wires for 4-20 mA type instruments or thermocouple wires assigned to the same control panel may be run in the same conduit. Shielded instrument signal wires, thermocouple wires, and shielded 2-wire intercom wires may be run in the same conduit. No other wires will be permitted in an instrument signal/2-wire intercom conduit. Conduit shall be RMC.

E. Raceways: All raceways are to be exposed. Install parallel and perpendicular to nearby surfaces or structural members and follow the surface contours as much as practical. Make bends and offsets so the inside diameter is not effectively reduced. Keep the legs of a bend in the same plane and the straight legs of offsets parallel. Conduits shall slope away from loads to keep moisture from entering the load. Run parallel or banked raceways together. Make bends in parallel or banked runs from the same centerline so that the bends are parallel. Factory elbows may be used in banked runs only where they can be installed parallel. This requires that there be a change in the plane of the run, such as from wall to ceiling and that the raceways be of the same size. In other cases, provide field bends for parallel raceways. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot water pipes. Install horizontal raceway runs above water and steam piping.

F. Space raceways, fittings, and boxes 0.25 inch from mounting surface in NEMA 4 and NEMA 7 areas. Spacers shall be one-piece construction of stainless steel material.

G. Flexible Connections: Use short length (maximum 6 feet for lighting fixtures; maximum 3 feet for all other equipment) of flexible conduit for equipment subject to vibration, noise transmission, or movement, and all motors. Use liquidtight flexible conduit in wet locations and rated flexible connections for hazardous locations. Install separate ground conductor across flexible connections.

H. Join raceways with fittings designed and approved for the purpose and make joints tight. Where joints cannot be made tight, use bonding jumpers to provide electrical continuity of the raceway system. Where terminations are subject to vibration, use bonding bushings or wedges to assure electrical continuity. Where subject to vibration or dampness, use insulating bushings to protect conductors.

I. Use raceway fittings that are of types compatible with the associated raceway and suitable for the use and location. Use only factory-coated fittings approved for use with that material.

J. Install raceway sealing fittings in accordance with the manufacturer's written instructions. Locate fittings at suitable, approved, accessible locations and fill them with UL listed sealing compound. Install raceway sealing fittings at the following points and elsewhere as indicated:
   1. Where conduits enter or leave hazardous locations.
   2. Where conduits enter or leave NEMA 4X areas.
   3. Where conduits pass from warm locations to cold locations, such as the boundaries of refrigerated spaces and air-conditioned spaces.
   4. Where required by the NEC.

K. Install electrical boxes in those locations which ensure ready accessibility to enclosed electrical wiring. Provide knockout closures to cap unused knockout holes where blanks have been removed.

L. Install device boxes at the height above the floor as follows for:
   1. Light switches, 4 feet.
   2. Receptacles and telephone jacks, 18 inches except in NEMA 4 and 4X areas, 4 feet.

M. Fasten electrical boxes firmly and rigidly to substrates or structural surfaces to which attached, or solidly embed electrical boxes in concrete masonry.

N. Support exposed raceway within 1 foot of an unsupported box and access fittings. In horizontal runs, support at box and access fittings may be omitted where box or access fittings are independently supported and raceway terminals are not made with chase nipples or threadless box connectors.

O. Terminations: Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely and install the locknuts with dished part against the box. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box and tighten the chase nipples so no threads are exposed.

P. Complete installation of electrical raceways before starting installation of conductors within raceways and prevent foreign matter from entering raceways by using temporary closure protection.

Q. Install pull wires in empty raceways: Use No. 14 AWG zinc-coated steel or monofilament plastic line having not less than 200-pound tensile strength. Leave not less than 12 inches of slack at each end of the pull wire.

3.03 WIRE AND CABLE INSTALLATION

A. Use pulling means including fish tape, cable, rope, and basket weave wire/cable grips which will not damage cables or raceways. Pull conductors simultaneously where more than one is being installed in same raceway. Use UL listed pulling compound or lubricant where necessary.

B. Keep branch circuit conductor splices to minimum. Splice feeders only where indicated. Use a standard kit. No splices are allowed for instrument and telephone cables except at indicated splice points.

C. Install splice and tap connectors which possess equivalent or better mechanical strength and insulation rating than conductors being spliced. Use splice and tap connectors which are compatible with conductor material and are UL listed as pressure type connectors.

D. Provide adequate length of conductors within electrical enclosures and train conductors to terminal points with no excess. Bundle multiple conductors, with conductors larger than No. 10 AWG cabled in individual circuits. Make terminations so there is no bare conductor at terminal.

E. Terminate power conductors at equipment using pressure-type terminals specifically designed for type of terminations to be made. Terminate no more than 2 conductors No. 8 AWG and smaller within the same pressure-type terminal. These 2 conductors shall be no more than 4 wire gauge sizes apart. Terminate no more than 1 conductor larger than No. 8 AWG within any pressure-type terminal.

F. Seal wire and cable ends until ready to splice or terminate.

3.04 CUTTING AND PATCHING

A. Perform cutting and patching as necessary and seal all penetration dust and water tight. In addition, the following requirements apply.
   1. Cut, remove, and legally dispose of selected electrical equipment, components, and materials as indicated including, but not limited to, removal of electrical items indicated to be removed and items made obsolete by new Work. Protect structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed. Provide and maintain temporary partitions or dust barriers adequate to prevent spread of dust and dirt to adjacent areas.
   2. Patch existing finished surfaces and building components using new materials matching existing materials.

3.05 EQUIPMENT CHECKOUT AND TESTING

A. In addition to testing recommended by equipment or material supplier and called for in equipment or material specification, perform the following.

B. Motor Testing: Motor insulation shall be tested by using a 500 VDC (minimum) megger and applying test until a constant megohm reading of the following magnitude is obtained:

$R_{min.} = 4 (KV + 1)$ at 25 degrees C winding temp.
$R_{min.} = IV + 1$ at 40 degrees C winding temp.

   1. If motors do not meet requirements of megger test, blow hot air through motors to dry out and repeat until test is passed. If desirable, drying can be done by applying an electrical potential to equipment. However, in no case, induced or direct, shall voltage or current exceed continuous rating of equipment being dried.

2. After passing megger test, motors shall be hi-pot tested at 200 percent rated voltage for a minimum of 1 minute.

C. Equipment Testing: The following tests which are applicable for a particular item of equipment shall be performed:
   1. Megger power circuit breakers and circuits supplied phase-to-phase and phase-to-ground (100 megohms minimum).
   2. Test, time, and set protective relays. Relays shall be timed at various multiples (minimum of 3 points) of the pick-up value to determine agreement with published curves and adjust as necessary to agree with coordination study required settings. Exact tests to be performed vary with type of relay. Manufacturer's instructions for relay shall be complied with.
   3. After Work has been completed, demonstrate to CONSTRUCTION MANAGER's Representative that entire electrical installation is in proper working order and will perform functions for which it was designed by functional testing.
   4. Make any specific tests required by the manufacturer's installation instructions.

D. Check-out Procedures. In general, check-out procedures (as listed below) which are applicable for a particular item of equipment shall be performed:
   1. Vacuum interior of cubicles and remove foreign material.
   2. Wipe clean with a lint-free cloth insulators, bushings, bus supports, etc.
   3. Check and adjust time delay, under-voltage devices, phase relay, over-current relays, etc., as required by coordination study or CONSTRUCTION MANAGER.
   4. Fill motor bearings requiring oil.
   5. Check and change, as required, thermal overload heater elements to correspond with motor full-load current and service factors of installed motor.
   6. Check direction of rotation of motors and reverse connections if necessary. Check rotation with motor mechanically uncoupled where reverse rotation could damage equipment.
   7. Check exposed bolted power connections for tightness.
   8. Check operation of breakers, contactors, etc., and control and safety interlocks.
   9. Check tightness of bolted structural connections.
   10. Check leveling and alignment of enclosures.
   11. Check operating parts and linkages for lubrication, freedom from binding, vibration, etc.
   12. Check tightness and correctness of control connections at terminal blocks, relays, meters, switches, etc.
   13. Clean auxiliary contacts and exposed relay contacts after vacuuming.

END OF SECTION

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SECTION 16060 –

GROUNDING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Electrical grounding and bonding Work as follows:
   1. Solidly grounded.

B. Applications of electrical grounding and bonding Work in this Section:
   1. Underground metal piping.
   2. Underground metal water piping.
   3. Underground metal structures.
   4. Metal building frames.
   5. Electrical power systems.
   6. Grounding electrodes.
   7. Separately derived systems.
   8. Raceways.
   9. Service equipment.
   10. Enclosures.
   11. Equipment.
   12. Lighting standards.

1.02 SUBMITTALS

A. Shop Drawings: Submit Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
   1. Product Data: Submit manufacturer's data on grounding and bonding products and associated accessories.

1.03 QUALITY ASSURANCE

A. Codes and Standards:
   1. UL Compliance: Comply with applicable requirements of UL Standards No. 467, "Electrical Grounding and Bonding Equipment," and No. 869, "Electrical Service Equipment," pertaining to grounding and bonding of systems, circuits, and equipment. In addition, comply with UL Standard 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors." Provide grounding and bonding products which are UL listed and labeled for their intended usage.
   2. IEEE Compliance: Comply with applicable requirements and recommended installation practices of IEEE Standards 80, 81, 141, and 142 pertaining to grounding and bonding of systems, circuits, and equipment.
   3. Refer to NFPA 780 for Lightning protection minimum standards.

PART 2 - PRODUCTS

2.01 GROUNDING AND BONDING

A. Materials and Components:
   1. Except as otherwise indicated, provide electrical grounding and bonding systems indicated; with assembly of materials including, but not limited to, cables/wires, connectors, solderless lug terminals, grounding electrodes and plate electrodes, bonding jumper braid, surge arresters, and additional accessories needed for complete installation. Where more than one type component product meets indicated requirements, selection is Installer's option. Where materials or components are not indicated, provide products which comply with NEC, UL, and IEEE requirements and with established industry standards for those applications indicated.
   2. Conductors: Electrical copper grounding conductors for grounding system connections that match power supply wiring materials and are sized according to NEC.
   3. Ground Bus: 0.25 inch by 1 inch minimum copper ground bus where indicated.
   4. Service Arrester: 2-pole, 1 phase, 120/240 volts, No. 14 AWG 3-wire including ground, 18-inch leads, with watertight enclosure.
   5. Grounding Electrodes: Steel with copper welded exterior, 3/4-inch diameter by 10 feet, provide screw connection where plans indicate total installed depth greater than 10 feet.
   6. Electrical Grounding Connection Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing, welding materials, bonding straps, as recommended by accessories manufacturers for type services indicated.

PART 3 - EXECUTION

3.01 INSTALLATION OF ELECTRICAL GROUNDING AND BONDING SYSTEMS

A. Connect grounding conductors to underground grounding electrodes using exothermic weld process or mechanical compression type connectors.

B. Ground electrical service system neutral at service entrance equipment to grounding electrodes.

C. Ground each separately derived system neutral to effectively grounded metallic water pipe, effectively grounded structural steel member, and separate grounding electrode.

D. Connect together system neutral, service equipment enclosures, exposed noncurrent carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, receptacle ground connectors, and plumbing systems.

E. Terminate feeder and branch circuit insulated equipment grounding conductors with grounding lug, bus, or bushing.

F. Connect grounding electrode conductors to 1-inch diameter or greater, metallic cold water pipe using a suitably sized ground clamp. Provide connections to flanged piping at street side of flange.

G. Connect building reinforcing steel, building steel beam, building steel roof and walls and duct bank and vault reinforcing steel to ground mat using No. 4/0 AWG bare copper grounding cable.

H. Bond grounding cables to both ends of metal conduit or sleeves through which such cables pass.

I. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque-tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, tighten connections to comply with tightening torque values specified in UL 486A to assure permanent and effective grounding.

J. Install braided type bonding jumpers with code-sized ground clamps on water meter piping to electrically bypass water meters.

K. Route grounding connections and conductors to ground and protective devices in shortest and straightest paths as possible while following building lines to minimize transient voltage rises. Protect exposed cables and straps where subject to mechanical damage.

L. Apply corrosion-resistant finish to field connections, buried metallic grounding and bonding products, and places where factory applied protective coatings have been destroyed and are subjected to corrosive action.

3.02 FIELD QUALITY CONTROL

A. Upon completion of installation of electrical grounding and bonding systems, test ground resistance with ground resistance tester using the 3-point fall of potential method. Testing shall be performed during normal dry weather conditions with at least 5 non-rain days elapsing prior to test. Where tests

show resistance-to-ground is over 5 ohms, take appropriate action to reduce resistance to 5 ohms or less by driving additional ground rods; then retest to demonstrate compliance.

B. Test ground paths for continuity by applying a low DC voltage source of current, capable of furnishing up to 100 amps, between electrical equipment grounds and ground grid. Grounding path must conduct a 100-amp current at a resistance of 0.010 ohms or less as calculated from circuit voltage.

END OF SECTION

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SECTION 16070

SUPPORTING DEVICES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Secure support from the building structure for electrical items by means of hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings.

1.02 SUBMITTALS

A. Shop Drawings: Submit Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
   1. Product data for each type of product specified.

1.03 QUALITY ASSURANCE

A. Electrical components shall be listed and labeled by UL, ETL, CSA, or other approved, nationally recognized testing and listing agency that provides third-party certification follow-up services.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
   1. Slotted Metal Angle and U-Channel Systems:
      a. Allied Tube & Conduit.
      b. American Electric.
      c. B -Line Systems, Inc.
      d. Cinch Clamp Co., Inc.
      e. GS Metals Corp.
      f. Haydon Corp.
      g. Kin-Line, Inc.
      h. Unistrut Diversified Products.
   2. Conduit Sealing Bushings:
      a. Bridgeport Fittings, Inc.
      b. Cooper Industries, Inc.
      c. Elliott Electric Mfg. Corp.
      d. GS Metals Corp.
      e. Killark Electric Mfg. Co.
      f. Madison Equipment Co.
      g. L.E. Mason Co.
      h. O-Z/Gedney.
      i. Producto Electric Corp.
      j. Raco, Inc.
      k. Red Seal Electric Corp.

l. Spring City Electrical Mfg. Co.
m. Thomas & Betts Corp.

2.02 COATINGS

A. Coating: Not allowed, provide all 316 stainless support, fasteners, fittings and mounting hardware.

2.03 MANUFACTURED SUPPORTING DEVICES

A. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps. Do not use PVC clamps, straps or hangers, use only stainless steel.

B. Fasteners. Types, materials, and construction features as follows:
1. Expansion Anchors: Stainless steel wedge or sleeve type.
2. Toggle Bolts: Stainless steel springhead type.
3. Hanger Rods: 0.375-inch diameter minimum, stainless steel.

C. Conduit Sealing Bushings: Factory fabricated, watertight conduit sealing bushing assemblies suitable for sealing around conduit or tubing passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.

D. U-Channel Systems: 12 gauge or 0.105-inch-thick stainless steel channels, with 9/16-inch-diameter holes, at a minimum of 8 inches on center in top surface. Provide fittings and accessories that mate and match with U-channel and are of same manufacturer.

2.04 FABRICATED SUPPORTING DEVICES

A. Shop- or field-fabricated supports or manufactured supports assembled from U-channel components.

B. Stainless Steel Brackets: Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.

C. Pipe Sleeves: Provide a waterstop on pipe sleeves. Provide pipe sleeves of 2 standard sizes larger than conduit/pipe passing through it and of one of the following:
1. Sheet Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate sleeves from the following gauge metal for sleeve diameter noted:
a. 3-inch and smaller: 20-gauge.
b. 4-inch to 6-inch: 16-gauge.
c. Over 6-inch: 14-gauge.
2. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe.
3. Plastic Pipe: Fabricate from Schedule 80 PVC plastic pipe

PART 3 - EXECUTION

NOT USED

END OF SECTION

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SECTION 16075

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Identification of electrical materials, equipment, and installations. It includes requirements for electrical identification components including, but not limited to, the following:

1. Identification labeling for cables and conductors.
2. Operational instruction signs.
3. Warning and caution signs.
4. Equipment labels and signs.

1.02 SUBMITTALS

A. Shop Drawings: Submit Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
1. Product Data for each type of product specified.

PART 2 - PRODUCTS

2.01 ELECTRICAL IDENTIFICATION PRODUCTS

A. Colored Adhesive Marking Tape for Wires and Cables: Self-adhesive, vinyl tape not less than 3 mils thick by 1 inch to 2 inches in width.

B. Pre-tensioned Flexible Wraparound Colored Plastic Sleeves for Cable Identification: Flexible acrylic bands sized to suit raceway diameter and arranged to stay in place by pre-tensioned gripping action when coiled around the cable.

C. Wire/Cable Designation Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound, cable/conductor markers with pre-printed numbers and letter.

D. Aluminum, Wraparound Cable Marker Bands: Bands cut from 0.014-inch-thick aluminum sheet, fitted with slots or ears for securing permanently around wire or cable jacket or around groups of conductors. Provide for legend application with stamped letters or numbers.

E. Engraved, Plastic Laminated Labels, Signs, and Instruction Plates: Engraving stock melamine plastic laminate, 1/16 inch minimum thick for signs up to 20 square inches or 8 inches in length; 1/8-inch thick for larger sizes. Engraved legend in white letters on black face and punched for mechanical fasteners.

F. Baked Enamel Warning and Caution Signs for Interior Use: Pre-printed aluminum signs, punched for fasteners, with colors, legend, and size appropriate to the location.

G. Exterior Metal-Backed Butyrate Warning and Caution Signs: Weather-resistant, nonfading, pre-printed cellulose acetate butyrate signs with 20-gauge galvanized steel backing, with colors, legend, and size appropriate to location. Provide 1/4-inch grommets in corners for mounting.

H. Fasteners for Plastic Laminated and Metal Signs: Self-tapping stainless steel screws or Number 10/32 stainless steel machine screws with nuts and flat and lock washers.

I. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18 inch minimum width, 50-pound minimum tensile strength, and suitable for a temperature range from minus 50 to 350 degrees F. Provide ties in specified colors when used for color coding.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in electrical identification Work with corresponding designations specified or indicated. Install numbers, lettering, and colors as approved in submittals and as required by Code.

B. Conductor Color Coding: Provide color coding for secondary service, feeder, and branch circuit conductors throughout the Project secondary electrical system following CONSTRUCTION MANAGER's method of phase identification or as follows:

Phase	480/277 Volts
A	Yellow
B	Brown
C	Orange
Neutral	White
Ground	Green

C. Wiring Standards:
1. 480/277 Volt, 3-Phase Power:
   a. Brown.
   b. Orange.
   c. Yellow.
   d. Grey Neutral.
2. 208 Volt, 3-Phase Power:
   a. Black.
   b. Red.
   c. Blue.
3. 240/120 Volt, 1-Phase Power:
   a. Black.
   b. Red.
   c. White Neutral.

4. Motor Leads, Control Cabinet/MCC:
    a. Black, numbered L1-T1, etc.
5. Control Wiring:
    a. Red Control circuit wiring that is de-energized when the main disconnect is opened.
    b. Yellow Control circuit wiring that remains energized when the main disconnect is opened.
    c. Blue DC.
    d. Green Ground.

D. Use conductors with color factory applied entire length of conductors except as follows:
    1. The following field applied color coding methods may be used in lieu of factory-coded wire for sizes larger than No. 10 AWG.
        a. Apply colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last 2 laps of tape with no tension to prevent possible unwinding. Use 1-inch-wide tape in colors as specified. Do not obliterate cable identification markings by taping. Tape locations may be adjusted slightly to prevent such obliteration.
        b. In lieu of pressure-sensitive tape, colored cable ties may be used for color identification. Apply 3 ties of specified color to each wire at each terminal or splice point starting 3 inches from the terminal spaced 3 inches apart. Apply with a special tool or pliers, tighten for snug fit, and cut off excess length.

E. Power Circuit Identification: Securely fasten identifying metal tags of aluminum wraparound marker bands to cables, feeders, and power circuits in vaults, pull boxes, junction boxes, manholes, and switchboard rooms with 1/4-inch steel letter and number stamps with legend to correspond with designations on Drawings. If metal tags are provided, attach them with approximately 55-pound test monofilament line or one-piece self-locking nylon cable ties.

F. Install wire/cable designation tape markers at termination points, splices, or junctions in each circuit. Circuit designations shall be as indicated on Drawings.

END OF SECTION

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SECTION 16120

WIRES AND CABLES

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes the following:
   1. Low-Voltage Wire and Cable.
   2. Instrument Cable.
   3. Multiconductor Control Cable.
   4. Local Area Network Wiring (LAN).

1.02 SUBMITTALS

A. Shop Drawings: Submit Shop Drawings covering the items included under this Section. Include Shop Drawings of wires, cables, connectors, splice kits, and termination assemblies.

B. Reports of field tests.

1.03 QUALITY ASSURANCE

A. UL Compliance: Provide components which are listed and labeled by UL.

B. NEMA/ICEA Compliance: Provide components which comply with following standards:
   1. NEMA WC 70-1999/ICEA S-95-658-1999, Nonshielded Power Cables Rated 2,000 Volts or Less for the Distribution of Electrical Energy.

C. IEEE Compliance: Provide components which comply with the following standard.
   1. Standard 82, Test procedures for Impulse Voltage Tests on Insulated Conductors.

D. Network Wiring Experience: Electrical contractor must be able to prove to the satisfaction of CONSTRUCTION MANAGER that it has significant experience in the installation of Local Area Network cable systems. Installation must include installation of Network cable, cable termination, knowledge of interconnect equipment, and a thorough knowledge of testing procedures.

E. Labeling: Handwritten labels are not acceptable. All labels shall be machine printed on clear or opaque tape, stenciled onto adhesive labels, or typewritten onto adhesive labels. The font shall be at least 1/8 inch in height, block characters, and legible. The text shall be of a color contrasting with the label such that is may be easily read. If labeling tape is utilized, the font color shall contrast with the background. Patch panels shall exhibit workstation numbers or some type of location identifier, in sequential order, for all workstations or devices attached. Each Network cable segment shall be labeled at each end with its respective identifier.

F. Network Wiring Interconnect Equipment (Patch Panels): Interconnect equipment shall be used in all Local Area Network cable installations. Interconnect equipment mounted in racks shall be affixed to

the rack by at least 4 screws. All interconnect devices shall be assembled and installed in accordance with the manufacturer's instructions and recommendations.

G. Patch Cords: Patch cords shall be provided for each Local Area Network port on the patch panel. Patch cords shall meet or exceed technical specifications of all installed Local Area Network cable. Patch cord connectors shall be matched with patch panel connector type and network module connector type as required.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
   1. Low-Voltage Wire and Cable:
      a. American Insulated Wire Corp.
      b. General Cable.
      c. The Okonite Co.
      d. Southwire Co.
   2. Connectors for Low-Voltage Wires and Cable Conductors:
      a. AMP.
      b. O-Z/Gedney Co.
      c. Square D Company.
      d. 3M Company.
   3. Instrument Cable:
      a. Belden (Trade Nos. 1120A and 1118A).
   4. Local Area Network Cable:
      a. Belden 7882A/7883A, or equal.

2.02 LOW-VOLTAGE WIRES AND CABLES

A. Conductors: Provide stranded conductors conforming to ASTM Standards for concentric stranding, Class B. Construction of wire and cable shall be single conductor (1/c) unless multiconductor cable is shown by notation in form (x/c) where x indicates the number of separate insulated conductors per cable. Aerial cable shall be UV rated multiconductor with grounding messenger cable.

B. Conductor Material: Copper. Minimum size power wire shall be No. 12 AWG.

C. Insulation: Provide XHHW-2 or THWN-2(T90) insulation for power conductors used in single- and 3-phase circuits with more than 120 volts to ground. Provide RHW/USE, XHHW-2, or THWN/THHN insulation for power conductors used in single- and 3-phase circuits with 120 volts or less to ground
   1. Provide RHW, THHN/THWN, or XHHW-2 insulation for grounding conductors installed in raceways.
   2. Provide THHN/THWN insulation for control conductors.

D. Aerial Cable: Provide XLP insulated copper conductors ACSR messenger cable.

2.03 CONNECTORS FOR LOW-VOLTAGE WIRES AND CABLES

A. Provide UL listed factory fabricated, solderless metal connectors of sizes, ampacity ratings, materials, types, and classes for applications and services indicated. Use connectors with temperature ratings equal to or greater than those of the wires upon which used.

2.04 INSTRUMENT CABLE

A. Instrument Cable: 600 volt minimum insulated shielded cable with two or more twisted No. 14 or No. 16AWG stranded copper conductors; PVC, nylon, or polyethylene outer jacket; and 100 percent foil shielding.

2.05 MULTICONDUCTOR CONTROL CABLE

A. Multiconductor Control Cable: Concentrically cabled No. 14 AWG stranded copper conductors with saturated interstitial fillers; overall binder of nylon or similar material; and PVC jacket. Quantity of conductors shall be as indicated on Drawings. Provide Type 2010 individual conductor insulation unless otherwise indicated on Drawings as one of the following:
   1. Type ISS: 15 mils polyethylene with 5 mils nylon.
   2. Type 2010: 20 mils polyethylene with 10 mils PVC.
   3. Type 3015: 30 mils polyethylene with 15 mils PVC.

2.06 NETWORK CABLE

A. Cat 5e: Insulated and 4-Pair, U/UTP-Unshielded, Riser-CMR, 24AWG solid soft copper conductors, Polyolefin Insulation, Ripcord, PVC Jacket with color coding per Telephone Industry Standards and IPCEA 5-56-454-1 and insulation thickness per IPCEA 61-402. Suitable for use with 1000BaseT, Gigabit Ethernet, POE, POE+, 100BaseTX, Fast Ethernet, 100BaseVG ANYLAN, 155ATM, 622ATm, NTSC/PAL, Component or Composite Video, AES/EBU Digital Video and RS-422. UL1666 Flame Tested.

B. Fiber: 62.5/125 microns (OM1) glass fiber, RML BW per TIA/EIA 455-204 and IEC 60793-1-41 up to 1Gb/s laser based system, OFLBW per TIA/EIA455-204 and IEC 60793-1-41 for legacy and LED based systems to 100Mb/s.

PART 3 - EXECUTION

3.01 FIELD QUALITY CONTROL

A. Prior to energizing, check installed 480 volt, 3-phase power circuits and higher wires and cables with a 1,000-volt megohm meter to determine insulation resistance levels to assure requirements are fulfilled. Minimum acceptable megohm meter reading is 100 megohms held at a constant value for 15 seconds. A certified copy of megohm meter tests shall be submitted to CONSTRUCTION MANAGER. Test reports shall include ambient temperature and humidity at time of testing. Notify CONSTRUCTION MANAGER 48 hours prior to test with schedule.

B. Local Area Network (LAN) Cable Tests: Testing of all cable segments shall be completed in compliance with EIA/TIA-568-B.1 Standards. Testing shall be done by Electrical Contractor with at least 5 years of experience in testing Network cabling systems.
   1. TESTING: Electrical Contractor shall test each network cable segment. CONSTRUCTION MANAGER reserves the right to have representation present during all or a portion of the testing process. Electrical Contractor must notify CONSTRUCTION MANAGER 5 days prior to commencement of testing. If CONSTRUCTION MANAGER elects to be present during testing, test results will only be acceptable when conducted in the presence of CONSTRUCTION MANAGER.
   2. DOCUMENTATION (Network Cable): Electrical Contractor shall provide documentation to include test results and as-built Drawings. Network Cable Results: Handwritten results are acceptable provided the test is neat and legible. Copies of test results are not acceptable. Only original signed copies will be acceptable.
      a. Each cable installed shall undergo complete testing in accordance with TIA/EIA-568-B.1 to guarantee performance to this Standard.
      b. All required documentation shall be submitted within 30 days at conclusion of the project to CONSTRUCTION MANAGER.
      c. Test Criteria: Pass rate to conform to latest TIA/EIA-568-B.1 Standards that incorporate link performance testing through entire path, including cable, couplers, and jumpers.
   3. ACCEPTANCE: Acceptance of the Data Communications System, by CONSTRUCTION MANAGER, shall be based on the results of testing, functionality, and receipt of documentation.

C. Reports (non-LAN cable): Testing organization shall maintain a written record of observations and tests, report defective materials and workmanship, and retest corrected defective items. Testing organization shall submit written reports to CONSTRUCTION MANAGER.

END OF SECTION

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SPECIFICATION REVISION INDEX

Revision No.	Revision Date	Issued for	Signatures				
			Prepared By	Reviewed By	Project Engineer	Project Manager	Client
A	11/28/2016	60% Submittal			JG	STD	
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SECTION 16151

VARIABLE FREQUENCY DRIVE UNIT

PART 1 - GENERAL

1.01 DESCRIPTION

A. Provide complete simplex type variable frequency drive (VFD) units and appurtenances including drive reactors, DC chokes, harmonic filters, dV/dT filters, enclosures, and certain auxiliary items, as indicated and as specified, to provide a complete operating system.

B. Variable frequency drive unit shall be furnished, installed and electrically connected by the electrical subcontractor unless otherwise indicated in process or mechanical specifications and plans for skid or packaged equipment.

C. VFD units shall be manufacturer's standard technology and in production for a minimum of 2 years.

D. Provide control system operation, input and control signals, status signals and devices in accordance with Division 13.

E. Provide Underwriter's Laboratories listed drive components where applicable.

F. Provide VFD 3% load reactor when cable length between VFD and motor is greater than 100 feet and less than 200 feet, and dv/dt filters when cable length is 200 feet or greater in length to insure motor terminals do not experience overvoltage condition as defined by NEMA Standard MG-1, section 30.02.2.9.

G. Each VFD unit to be provided is to exhibit less than 5% voltage total harmonic distortion and less than 3% voltage distortion on each harmonic at their immediate upstream distribution bus as verified by calculation and testing. Harmonic current distortion to be in accordance with Table 2.02A. This bus to be referred to as the point of common coupling (PCC). Provide 3% line reactor on all 12 and 18 pulse VFD’s and 5% line reactor on all 6 pulse VFD’s. Reactors may be reduce or eliminated if VFD vendor harmonic calculations show compliance with these specifications and IEEE 519 distortion limits.

1.02 RELATED WORK

A. Division 1: General Requirements.

B. Section 11208: Submersible Wastewater Pumps

C. Section 11372: Rotary Positive Displacement Blowers.

1.03 REFERENCES

A. Underwriter's Laboratories Inc. (U.L.):

1. UL-508 Electrical Industrial Control Equipment.

B. National Electrical Manufacturers Association (NEMA): MG 1.

C. National Fire Protection Association (NFPA):

1. NFPA-70 National Electric Code.

1.04 SUBMITTALS

A. Shop Drawings: Submit the following in accordance with Section 01340 – Shop Drawings and Submittals:

1. Shop Drawings: Provide a complete list of equipment components, and materials, including manufacturer's descriptive and technical literature, and catalog cuts. Provide complete wiring, system interconnection and schematic diagrams for the equipment and controls furnished including external interlocked and controlled components, equipment layout, time versus current curves for protective devices and any other details required to demonstrate that the system and the required external controls has been coordinated and will properly function as designed.

a. Provide data to verify that drives can be used for motor lead lengths up to 60 feet without output filters or VFD cable. Include information from the VFD manufacturer or output filter or cable manufacturer (if required) stating that the motor terminal voltage limitations as defined by NEMA Standard MG-1, section 31.40.4.2, are met. For VFD’s located more than a cable length is greater than 100 feet and less than 200 feet, and dv/dt filters when cable length is 200 feet or greater in length to insure motor terminals do not experience overvoltage condition as defined by NEMA Standard MG-1, section 30.02.2.9.Submit Harmonic Compliance Certificate based on theoretical calculations prior to raceway rough-ins for approval.

b. Each VFD unit to be provided is to exhibit less than 5% voltage total harmonic distortion and less than 3% voltage distortion on each harmonic at their immediate upstream distribution bus as verified by calculation and testing. Harmonic current distortion to be in accordance with Table 2.02A. This bus to be referred to as the point of common coupling (PCC). Provide 3% line reactor on all 12 and 18 pulse VFD’s and 5% line reactor on all 6 pulse VFD’s. Reactors may be reduce or eliminated if VFD vendor harmonic calculations show compliance with these specifications and IEEE 519 distortion limits.

c. Provide enclosure drawings and details showing all dimensions and construction details.

2. Submit information relative to location and expertise of local service office and personnel.

3. For informational purposes only, provide installation and anchoring details to meet earthquake requirements as specified and indicated on structural drawings.

4. For informational purposes only, submit manufacturer's printed installation instructions.

5. Spare Parts Data: Submit a list of spare parts for the equipment specified.

6. Operating and Maintenance Instruction Manuals:

a. Furnish:

(1) Operating instruction manuals outlining step-by-step procedures required for system startup and operation.

(2) Manufacturer's name, model number, service manual parts list.

(3) Brief description of equipment and basic operating features.

(4) Maintenance instruction manuals outlining maintenance procedures.

(5) Troubleshooting guide listing possible breakdown and repairs.

(6) Point-to-point connection wiring diagram for the system.

(7) Performance Test Reports: Upon completion of installed system, submit in booklet form all shop and field tests performed to prove compliance with specified performance criteria.

7. Prior to raceway rough-in, confirm conduit and wire size. Comply with NEC Article 430 Section 122 for power conversion equipment and adjust sizes shown on plans to meet the rating of the VFD provided.

1.05 QUALITY ASSURANCE

A. Ensure that conduit size and wire quantity, size, and type are suitable for the equipment supplied. Coordinate all design information with the Electrical Contractor. Review the

proper installation of each type of VFD unit with the equipment supplier prior to installation.

1. Services of Service Engineer, specifically trained on type of equipment specified. Man-day requirements listed exclusive of travel time.

    a. Assist in location of devices, methods of mounting, field erection, etc.: 1 man-day.

    b. Start-up and testing: 3 man-days.

    c. At the end of start-up service provide for a maximum of six members of the owners staff at the facility site to receive training from the startup/testing service Engineer: 1 man-day.
    d. Service-inspections during first year of operation, for use at Owner's request, and exclusive of repair, malfunction or other trouble-shooting service calls: 2 man-days.

    e. Man-day is defined as one 8-hour day, excluding travel time.

1.06 DELIVERY, STORAGE AND HANDLING

A. Shipping:

1. Ship equipment and materials, except where partial disassembly is required by transportation regulations or for protection, complete with identification and quantity of items.

2. Pack spare parts in containers bearing labels clearly designating contents and pieces of equipment for which intended.

3. Deliver spare parts after installation but as specified before start-up of drives. Deliver to Owner after completion of work.

B. Storage:

1. Inspect and inventory items upon delivery to site.

2. Store and safeguard equipment, material and spare parts.

1.07 WARRANTY AND SERVICE:

A. Provide in accordance with Section 01740: Warranties and Bonds, and as specified.

B. Guarantee components, parts, and assemblies supplied by manufacturer against defects in materials and workmanship for a period of 24 months after turning the equipment over to

the Owner, and in this time period include onsite, parts and labor warranty. All labor to be performed by local factory trained service engineers.

C. Ensure that equipment manufacturer has local branch office staff with trained, full-time employees who are capable of performing testing, inspecting, repair, and maintenance services.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturer shall have at least five years commercial experience in the manufacture, operation and servicing of equipment of type, size, quality, performance, and reliability equal to that specified.

B. Variable Frequency Drive Units:

1. Square D Company.

C. VFD Input Filters and Output Filters/Reactors:

1. Trans-Coil, Inc.

2. MTE Corporation.

3. Power Quality International.

4. Or acceptable equivalent product.

2.02 PROVISIONS

A. Service Conditions:

1. Ambient Temperature Range: 0 deg. C to 40 deg. C.

2. Operational Humidity: Up to 90 percent non-condensing.

3. Environment: Enclosure NEMA 12.

4. Altitude: Below 3,300 ft. above sea level.

5. Input Power:

a. Nominal voltage - 460 volts (plus 10 percent or minus 10 percent), 3-phase, 3 wire.

b. Nominal Frequency - 60 Hertz (plus or minus 2 Hz.).

c. Service provided from feeder breaker on distribution bus.

B. Drive System: 0-500 HP Units

1. General:

a. Furnish solid state variable frequency, microprocessor type with Pulse Width Modulated (PWM) output wave form converter. The VFD shall employ a full wave rectifier to prevent input line notching, a DC bus choke, DC bus capacitors and Insulated Gate Bipolar Transistors (IGBT) as the output switching device to convert nominal 480 volts, 3 phase, 60 Hertz, 3 wire input power into adjustable-frequency 3 wire system at 0 to 480 volts, 3 phase, 0 to 60 Hertz output power. Provide output speed control of required motor under variable torque load or constant torque as required by the driven equipment.

b. Motor control circuits shall be wired in accordance with the requirements specified herein or indicated on the Drawings. Where not indicated, the control circuits shall be standard two-wire “start-stop” and the Contractor shall furnish wiring accordingly.

c. Variable frequency drive manufacturer shall be responsible for the successful application and operation of the entire drive and control system serving the motor and driven equipment. This includes the responsibility for obtaining loads, torque, speed and performance requirements from the respective sources and integrating these into a variable frequency drive system that fulfills the requirements of this Specification.

d. The Contractor and variable frequency drive system manufacturer are cautioned regarding the review and compliance with the total Contract Documents. Typical examples are circuit breakers, motor circuit protectors, magnetic starters, relays, timers, control and instrumentation products, pilot devices including pushbuttons, selector switches and pilot lights, enclosures, conduit, disconnect switches, terminal boxes, and other equipment.

e. Provide flux vector control type drives, also known as field-oriented control, with hard-wired motor speed feedback encoder or tachometer, for full torque at zero speed capability.

e. Provide VFD control which ensures accurate zero to full load torque control at low frequencies, including zero speed, with torque repeatability accuracy of 2% or better and torque response time less than 20 ms.

f. Provide on drive, a disconnecting device and fixed diode input rectifier (for a constant power factor).

g. For units rated 50 Hp or less, provide 6 pulse drives with 5% impedance input line reactor.

h. For units rated greater than 50 Hp, provide VFD with the following type three phase PWM rectifier section: 18-pulse.

   (1) The design shall be optimized for harmonic rich and high neutral current environment.

   (2) Provide 3% impedance input line reactor

i. All components of the drive shall be designed and sized for the abnormal condition of continuous operation of the driven equipment specified herein at loads up to 15% above rated full load.

j. RMS harmonic output of the drive not to provide more than 5 percent increase in motor heating over similar operation of the motor with zero harmonics in the current.

k. The unit shall withstand drive output terminal line-to-line and line-to-ground short circuits without component failure during start-up and during operation. Drive to safely shutdown until short is cleared.

l. NEMA type cabinet for each drive unit, as indicated on drawings and enclosure schedule. NEMA 4 and NEMA 4X enclosures to be provided with stainless steel hand operated quick disconnect devices. Provide hinged acrylic door with gasketing on front of door for each access to keypad controls.

m. For inverter rated squirrel cage motors, per NEMA Standard MG-1, part 31.40.4.2, the following limit values at the motor terminals are to be observed:

   (1) For motors with base rating voltage less than or equal to 600 volts, the peak instantaneous voltage must be limited to 1600 volts or less, with a voltage rise time greater than or equal to 0.1 micro-seconds.

n. The VFD manufacturer shall guarantee that the above voltage limits will be met with the motor installed up to 100 cable feet [30 m] from the VFD drive unit. If the VFD manufacturer is not able to guarantee that the above voltage limits will be met, provide a drive output filter or reactor, appropriately rated, located within the VFD enclosure and near the VFD output terminals, which shall ensure that the limitations listed above are maintained. A device located at the motor terminals is not acceptable.

o. The drive unit shall be of modular design to provide for ease and speed of maintenance.

p. Control circuits shall be isolated from power circuits. Unit to accept a 4-20 mA DC speed control signal from an isolated, ungrounded transmitter with unit in remote mode and from local door-mounted manual speed potentiometer or micro-processor type keypad with unit in local mode. The input 4-20 mA signal to be optically isolated from the drive run control circuit. Manual speed potentiometer or keypad controls to have adjustable minimum speed setting of 10 to 80% of full speed and maximum speed setting of 50 to 100% of full speed. The total speed setting to follow a linear time ramp, adjustable from 1-300 seconds for acceleration and deceleration control.

q. Provide trap filters for the drive unit to meet the requirements of the harmonic study under paragraph 2.02. Filters shall be provided with contactors and controlled by the VFD to remove them from the line when the drive is not operating. Contactors shall be provided with spare contacts for remote alarm and to energize status lamp at VFD enclosure.

r. VFD shall be capable of full rated output when powered by incoming voltage with Total Harmonic Distortion (THD) in excess of 10%.

s. Furnish series choke and capacitors on dc bus to reduce ripple in rectifier output and to reduce harmonic distortion reflected into incoming power feeders.

t. Properly size enclosure to dissipate heat generated by VFD within limits of specified service conditions. Provide NEMA enclosure type as specified on drawings. Provide integral fans or cooling systems as required by the application. NEMA 4 and 4X type enclosures to use hand-operated locking devices for door closing hardware. Circuit breaker interlocks to be able to be bypassed via lever on front door surface. NEMA 1 type enclosures to have keypad controls located on exterior of enclosure. Provide visual alarm indicator on cabinet door.

2. Performance characteristics:

a. Output amps: 110 percent of rated, continuous.

b. Current limit: Range 0 to 130% for constant torque applications, 0 to 110% for variable torque applications, for 1 minute minimum.

c. Acceleration time to top speed, 1-300 seconds, minimum, adjustable.

d. Deceleration time from top speed, 1-300 seconds, minimum, adjustable.

e. Frequency stability: +/- 0.5% (at 25 degrees C, +/10 degrees C) after reaching operating temperature.

f. Output voltage: Proportional to frequency with low speed boost.

g. Combined drive/and filtering efficiency, defined as motor shaft KW divided by VFD input KW, shall meet the following minimum requirements at the specified operating points:

(1) 97 percent at 60 Hz VFD output and 100 percent load.

(2) 92 percent at 50 Hz VFD output and 60 percent load.

h. VFD fundamental power factor shall be 0.98 or higher at all speeds and loads.

i. The VFD shall be capable of sustaining continued operation with a 30% dip in nominal line voltage. Output speed may decline only if current limit rating of the VFD is exceeded.

j. Losses to be utilized in drive system efficiency calculation shall include the input isolation transformer, harmonic filter and power factor correction if applicable. Auxiliary controls such as internal VFD control boards and cooling fans shall be included in all loss calculations.

3. Drive Protection:

a. General :

(1) Fault detection and trip circuits shall protect VFD and connected motor against line voltage transients, single-phase, power line overvoltage and undervoltage, output overvoltage and overcurrent, and VFD overtemperature. The VFD shall employ three (3) current limit circuits to provide trip free operation. The slow current regulation limit circuit shall be adjustable to a minimum 125% of the VFD's variable torque current rating. The rapid current regulation limit shall be adjustable to a minimum 170% of the VFD's variable torque current rating. The current switch off limit shall be fixed at a minimum 225% of the VFD's variable torque current rating.

b. Internal Protection: Minimum circuitry as follows:

(1) Current limiting, fast acting, semiconductor input fuses for protection of internal power semiconductors.

(2) Instantaneous output overcurrent trip max. - 200 percent.

(3) DC bus and control circuit transformer fusing.

(4) Grounded control chassis.

(5) Under and over voltage trip, 3 phases.

(6) Motor overload protection, with solid state relays.

(7) Fault reset push button.

(8) Line to ground faults.

(9) Input metal oxide varistor and input line reactor for transient protection.

(10) VFD overtemperature.

c. Troubleshooting: Diagnostic aids to indicate cause of fault; used to assist in troubleshooting circuit problems. Isolated Form C contacts for remote indication of alarms to include the following:

(1) Over/under voltage indication.

(2) Overcurrent trip indication.

(3) DC bus charged indication.

(4) Fault detection indication.

(5) Recycle start indication (to indicate that the unit tried to pick up load for three previous tries and failed).

d. Provide power loss ride through capability which will allow the logic to maintain control due to load inertia without faulting.

e. Provide a programmable automatic restart function which will provide a minimum with time delays between restarts of 3 restarts following a fault condition other than a ground fault, short circuit, internal fault, or user programmable fault condition. Restart type to be programmable for time delay or coasting motor restart.

C. Auxiliary Systems:

1. Provide variable frequency drive unit with appropriate power circuitry and auxiliary contacts for energizing and controlling the following devices associated with the motor, if required:

a. Space heaters (50 HP and above)

b. Solenoid valves

c. Remote indication of motor start and stop (isolated contacts)

D. Minimum Control Features:

1. LOCAL-REMOTE selection of Start/Stop control.

2. LOCAL/REMOTE selection of Speed Control.

3. Accept a grounded, isolated, 4-20 mA input remote speed control signal from an external device.

4. Provide a 4-20 mA output signal proportion to VFD output frequency for remote speed indication.

5. Provide Ethernet TCP/IP communication module

E. Devices:

1. Provide operating, monitoring or alarm indicating devices, on keypad, with minimum as follows:

a. System control selector switch (RUN/OFF/REMOTE) (When in RUN position drive will run).

b. System speed control selector switch (LOCAL/REMOTE) (When in LOCAL position, speed controlled by manual speed potentiometer).

c. Keypad controls to set speed in manual mode.

d. Speed indicating meter in percent speed to indicate speed of the converter powered motor.

e. Run time meter.

f. Alarm and status lights.

2.03 SHOP TESTING (18 Pulse Units Only)

A. Provide a factory performance test for each variable frequency drive unit. The test to consist of simulating the expected load to be driven. The drive to operate the actual motor load through the expected speed ranges. Test length to be a minimum of two hours.

B. Provide a factory burn-in test for 24 hours minimum and a control and alarm test on each drive unit by simulating each control signal and each alarm function to verify proper and correct drive unit action.

C. Provide typical prototype factory test data for short circuit testing of each type of drive supplied. Data to verify that each drive can be started into a line-to-line fault and line-to-ground fault on the drive terminals. Each drive can be operating at full load and be subjected to a line-to-line fault and line-to-ground fault on the drive terminals. All phases (A, B & C) to be included in test data.

D. Provide certified documentation of all tests performed.

E. Provide above stated tests in addition to routine factory tests.

F. Owner to have option to witness all factory tests. Notify Owner two weeks before all tests.

2.04 SPARE PARTS:

A. Provide in accordance with Section 01730: Operating and Maintenance Data, and as specified.

B. Provide one spare board or card, three diodes, for each horsepower size drive. Spares will be color-coded or otherwise keyed to their original counterpart such that improper installation of spare cards is impossible. In addition to the cards, the manufacturer shall provide three spares for all expendable items such as pilot lamps, power fuses, and control fuses. Provide one keypad for every three VFD of the same model.

PART 3 – EXECUTION

3.01 INSPECTION

A. Examine VFD location for satisfactory preparation. Check conduits and raceway location for connection to units.

B. Visually inspect delivered unit(s) and accessories for conformance with specification and drawings.

C. Verify availability of appropriate pacing signal.

D. Maintain variable frequency drive in upright position at all times.

E. Protect variable frequency drive against damage. Store drive in clean, dry environment with temperature and humidity within range as specified by drive manufacturer. Energize space heaters during storage as recommended by manufacturer.

3.02 INSTALLATION

A. Erect, install, and start-up equipment.

B. The VFD's shall be installed as shown on the Drawings and in accordance with the manufacturer's installation instructions.

C. Install VFD's to allow complete door swing required for component removal. This is specifically required where a VFD is set in the corner of a room.

D. Factory-trained service personnel, other than sales representatives, shall supervise field installation, inspect, make final adjustments and operational checks, make functional checks of spare parts, and prepare a final report for record purposes. Adjust control and instrument equipment until this equipment has been field tested.

3.03 RUBBER MATS

A. Three foot wide rubber mats shall be furnished and installed on the floor and in front of each VFD assembly. Refer to Section 16050 – Basic Electrical Requirements, (3.01) (M) (1).

3.04 FIELD TESTING

A. Provide in accordance with Section 01650 - Start-Up and Demonstration.

B. Perform testing checkout, and start-up for variable frequency drive equipment under technical direction of manufacturer's service engineer. Under no circumstances energize any portion of the drive system without authorization from manufacturer's technical representative.

C. Field Tests:

1. Test each drive over the total speed range that it will be required to operate through for the load being driven for a minimum of two hours. Determine for each drive, motor, and load combination the following at minimum speed, maximum speed, and at 1/3 and 2/3 points between the minimum and maximum speeds:

   a. Input power (kW), voltage, current and RMS power factor on the line side of the drive isolation device.

   b. Output to the driven load in kilowatts.

   c. For each drive, measure the harmonic voltage distortion and harmonic current distortion for each harmonic at the main distribution bus for maximum and minimum load conditions.

d. Measure the total harmonic voltage distortion and total harmonic current distortion at each PCC for maximum and minimum load conditions.

2. Test each drive by using the actual control signal for remote and local operation.

3. Test each driver's alarm functions.

4. Perform all tests in the presence of the Owner's representative.

5. Perform the above test in addition to the manufacturer's normal field tests.

6. Submit final test report with summary comparing field test data with harmonic analysis design calculated values for each drive.

3.05 CONTRACT CLOSEOUT

A. Provide in accordance with Section 01700 - Contract Closeout.

END OF SECTION

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SPECIFICATION REVISION INDEX

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			Prepared By	Reviewed By	Project Engineer	Project Manager	Client
A	11/28/2016	60% Submittal			JG	STD	
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SECTION 16220

MOTORS

PART 1 - GENERAL

1.01 SUMMARY

A. Section applies, in general, to all electric motor-driven equipment provided under Divisions 2 through 16 Sections. This Section shall supplement the detailed Equipment Specifications, but in cases of conflict, the Specifications indicated in this Section shall govern.

1.02 SUBMITTALS

A. Shop Drawings: Submit Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
   1. Submittals for motors shall accompany the specific equipment the motor is to be supplied with.
   2. Submit product literature for each motor.

B. Operation and Maintenance Manuals: Submit operation and maintenance manuals for items included under this Section.

1.03 QUALITY ASSURANCE

A. Electrical Codes, Ordinances, and Industrial Standards: The design, testing, assembly, and methods of installation of the wiring materials, electrical equipment, and accessories proposed under this Contract shall conform to the National Electrical Code and to applicable State and local requirements. UL listing and labeling shall be adhered to under this Contract. Any equipment that does not have a UL, FM, CSA, or other listed testing laboratory label, shall be furnished with a notarized letter signed by the supplier stating that the equipment furnished has been manufactured in accordance with the National Electrical Code and OSHA requirements. Any additional cost resulting from any deviation from codes or local requirements shall be borne by CONSTRUCTION MANAGER.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, motors shall be standard design and construction. Manufacturers offering products which may be incorporated in Work include:
   1. Motors:
      a. Marathon Blue Chip Series.
      b. Siemens, Inc.
      c. General Electric Co.
      d. Reliance Electric Co.
      e. U.S. Electric Motors.

B. For motors that are integrally constructed as a piece of equipment, such as appliances, hand tools, etc., and where manufacturer would be required to redesign equipment to meet these general specifications, it is the intent to allow such standard motors to be used, provided they do not exceed 1-1/2 horsepower and are suitable for use on standard power systems.

2.02 MATERIALS

A. Shop primers shall be Tnemec "77 Chem-Prime," or equal.

B. Rust preventive compound shall be equal to Dearborn Chemical "No-Ox-ID2W," Houghton "Rust Veto 344," or Rust-Oleum "R-9".

2.03 MANUFACTURED UNITS

A. Electrical Motors: Motor design and application shall comply with current ANSI, IEEE, NEMA, and AFBMA standards and with the NEC where applicable. They shall be squirrel cage induction motors rated 60 hertz, continuous duty for use in 40 degrees C ambient temperature. Motors shall comply with NEMA MG1-1993, Rev. 1, Part 31, Definite Purpose Inverter-Fed Motors whether used with variable frequency drives or not.
   1. The motors shall be sized within their rated loads under the specified conditions without utilizing the top 15 percent of the 1.0 or 1.15 service factor. Motor sizing measured at the motor output shaft shall include all loadings on the motor. Motor loadings shall include the maximum or specified load condition of the driven equipment plus all drive losses of components, located between the motor and the driven equipment.
   2. The motor winding temperature rise shall be NEMA Standard for the class of insulation used at the rated service factor load.
   3. The motors shall be capable of handling unfiltered voltage peaks of up to 1600 volts, and rise times of 0.1 micro-seocnds.

B. Motors 50 horsepower and larger shall have embedded passive temperature switches in the windings for use in the motor control circuit that will limit the winding temperature as defined by NEMA Standard MG1-12.53 Type 1. The contact shall be normally closed and rated to operate a 120 volt AC control relay (40 VA).

C. All integral horsepower motors shall have oversize conduit boxes with clamp-type grounding terminals inside which are effectively connected to all noncurrent-carrying motor parts.

D. All explosion-proof motors shall meet NEC Class 1, Division I, Group D, requirements with T2A temperature rating.

E. Unless these general specifications are supplanted by the detailed equipment specifications, motors shall be rated and constructed as follows:
   1. Below 1/2 Horsepower: Motors shall be rated 115/230 volts, single phase, but shall be suitable for use on 208 volt power system. They shall have permanently lubricated sealed bearings (antifriction type where high radial or axial thrusts are produced by the driven equipment). Standard motors shall be totally enclosed fan cooled, totally enclosed air-over, or totally enclosed nonventilated capacitor start type as shown on Equipment Schedule(s) or specified in the equipment specifications. Totally enclosed explosion-proof motors shall be provided where required per equipment specifications section.
   2. From 1/2 to 1-1/2 Horsepower: Motors shall be rated 115/230 volts single phase or shall be rated 230/460 volts 3-phase as indicated by Equipment Schedule(s). In either case they shall be suitable for use on 208 volt power systems under their given load conditions. They shall have bearings as in 2.03 F.1. The standard enclosures shall be totally enclosed fan cooled, totally enclosed nonventilated, totally enclosed explosion-proof, or open drip-proof as shown on Equipment Schedule(s) or specified in the equipment specifications.
   3. From 2 to 200 Horsepower: Motors shall be rated 230/460 or 460 volt, 3-phase. They shall be grease lubricated, ball bearing, Class B insulated, minimum or as specified. Horizontal motors shall be open drip-proof, totally enclosed fan-cooled or totally enclosed explosion-proof (NEC, Class I, Group D) as shown on Equipment Schedule(s) or specified in the equipment specifications. Vertical motors shall meet NEMA standard open drip-proof specifications as a vertical motor when called for or totally enclosed fan cooled or totally enclosed explosion-proof as shown on Equipment Schedule(s).

F. Horizontal and vertical motors may also be weather protected, Type I, and shall have encapsulated or sealed windings.

G. Special duty and severe environment application shall have motors which are designed specifically to meet the special conditions as specified.

H. The following symbols will be employed on Equipment Schedule(s) to indicate the required motor enclosure and construction features:
   1. TE Totally Enclosed, may be nonventilated, fan-cooled or air-over type.
   2. TENV Totally Enclosed Nonventilated.
   3. TEFC Totally Enclosed Fan-cooled.
   4. TEEP Totally Enclosed Explosion-proof, Class I, Div. I, Group D.
   5. ODP Open Drip-proof.
   6. WPI Weather Protected Type I.
   7. E/S Encapsulated or Sealed Windings.
      a. All motors with encapsulation or sealed windings shall have a water-tight conduit box.

I. See NEMA Standard MG1 for definition of above terms.

J. Motor Efficiency: Where Equipment Schedule(s) indicate that motors shall be designed for high efficiency, they shall meet or exceed the Motor Operating Characteristics shown on High Efficiency Motor Schedule No. 16220.2, appended to this Section. Guaranteed minimum efficiency at full load

shall be based on IEEE Standard 112, Test Method B. Nominal motor efficiencies are average expected values. Manufacturer's motor Shop Drawings shall indicate full compliance with the High Efficiency Motor Schedule No. 16220.2.

K. High Voltage Motors:

1. Horizontal Motors: The motors shall be induction motors designed for operating on a 3-phase, 60 hertz power system at the voltage indicated on Equipment Schedule(s). The design, construction, and performance characteristics of the motors shall conform to applicable provisions of the latest NEMA, IEEE, and ANSI standards. They shall perform in accordance with their nameplate ratings and be free of any defective material or workmanship.
2. The motors shall have a horsepower rating based on continuous operation (24 hours per day) at full load without exceeding the rated temperature rise above an ambient of 40 degrees C. The horsepower rating shall be adequate to operate the driven equipment under all normally expected operating conditions without overloading. Minimum full-load efficiency shall be at 92.5 percent and minimum full load power factor shall be 89 percent. Service factor shall be 1.0. Motor insulation shall be Class B or better. The motor temperature rise shall be NEMA standard for the class of insulation used for the rated service factor load. Motor shaft loading shall not exceed rated horsepower.
3. Motor manufacturer shall be responsible for obtaining the speed-torque characteristics of the driven equipment. Speed-torque curves showing the torque characteristics of both the motor and the driven equipment on the same graph together with WK^2 of both the motor and the driven equipment shall be submitted to CONSTRUCTION MANAGER. This information is to be included with submittal of outline Drawing for approval.
4. Motor shall be furnished with twelve (12) 100-ohm (or as required to be accepted as inputs to the motor protective device) platinum RTD Type temperature sensors for the stator windings; 2 sensors per phase per winding; and 2 temperature sensors for motor bearings; 1 sensor per bearing. RTD sensors shall be the 3-wire type and shall be wired to a terminal strip in a common frame mounted terminal box.
5. Motor insulation shall be full Class B. Coils shall be form wound, vacuum pressure impregnated and compactly shaped to fill the slots. Vacuum pressure impregnation shall be done by treating the entire stator with a minimum of 2 impregnations after the coils are placed in the lots. Winding and end connections shall be fully sealed against contaminants. The stator complete with winding shall be given additional dips and brakes. Motor end turns shall be adequately braced with nonshrinking material and shall withstand the stresses caused by full voltage starting.
6. Motors shall have weather protected Type I enclosures with top discharge air ventilation openings. Openings shall be equipped with easily removable guard screens. Motors shall have air inlet filters and space heaters.
7. Space heaters shall be 120 volt AC single phase in frame Sizes under 8600. Space heaters shall be 480 volt, 3-phase in frame Sizes 8600 and larger. Motors with space heaters shall include heater leads in a separate conduit box mounted on the motor frame. The conduit box shall have an access cover.
8. Motors shall have terminal boxes of adequate size for the construction of stress cones on incoming cable, surge arrestors and capacitors, and power factor correction capacitors. Terminal leads shall be minimum of 12 inches long and shall be equipped without lugs. Terminal boxes for motor leads shall have the following minimum dimensions: 20-inch H, 15-inch W, 10-inch D. They shall be diagonally split and furnished undrilled for conduit. The boxes shall be gasketed and suitable for mounting in any direction without allowing water to enter. Each motor shall be equipped with surge arrestor and capacitor overvoltage protection or equal. A

power factor correcting capacitor shall be provided for full load power factor correction of 0.96 minimum. Power factor correction capacitors may be floor-mounted with all connections to the motor terminal box being made through flexible conduit.

9. Bearing shall be of adequate size to take the load of the rotor, together with that of such parts of the shaft not carried by the driven machinery. A suitable base of high-grade cast iron shall be provided for mounting the motor.
10. Nameplates shall be metal and be installed with data as required by NEMA and also show locked rotor current and lead connection diagram.
11. The maximum overall noise level shall not exceed the level defined in the latest revision of NEMA Standard MG1-12.49 or MG1-20.49, whichever is applicable to the particular machine.
12. Certified routine shop tests shall be made on each motor for motors 1,500 horsepower or smaller. Full running shop tests shall be made on each motor larger than 1,500 horsepower. Test results shall be submitted to CONSTRUCTION MANAGER for CONSTRUCTION MANAGER's record.
13. Provisions for mounting a vibration motor sensor on each motor shall be provided. The mountings for the vibration sensors shall consist of a threaded mounting hole 1/2-20 UNF 2B 0.400-inch minimum depth full threads. Hole shall be located perpendicular, within 0.010-inch/inch, to the center line of a raised 2.0-inch diameter machined flat surface. Machined surface shall be flat within 0.005 inch. The machine surface is to be located on a raised boss on the bearing housing. The machined surface is to be oriented vertically and parallel plus or minus 3 degrees to the shaft center line such that the threaded hole is horizontal and perpendicular to the shaft center line within plus or minus 5 degrees.

L. Vertical Motors: The motors shall be induction motors designed for operation on a 3-phase, 60 hertz power system at the voltage indicated on Equipment Schedule(s). Motor housing shall be designed for vertical use and meet the NEMA specifications as a vertically oriented motor. The design, construction and performance characteristics of the motors shall conform to applicable provisions of the latest NEMA, IEEE, and ANSI Standards. They shall perform in accordance with their nameplate rating and be free of any defective material or workmanship.

1. The motors shall have a horsepower rating based on continuous operation (24 hours per day) at full load without exceeding 40 degrees C. The horsepower rating shall be adequate to operate the driven equipment under all normally expected operating conditions without overloading. Minimum full load efficiency shall be 92.5 percent and minimum full load power factor shall be 89 percent. Service factor shall be 1.0. Motor insulation shall be Class B or better. The motor temperature rise shall be NEMA standard for the class of insulation used for the rated service factor load. Motor shaft loading shall not exceed rated horsepower.
2. Motor manufacturer shall be responsible for obtaining the speed torque characteristics of the driven equipment. Speed-torque curves showing the torque characteristics of both the motor and the driven equipment on the same graph together with WK^2 of both the motor and the driven equipment shall be submitted to CONSTRUCTION MANAGER. This information is to be included with submittal of outline Drawing for approval.
3. Motors shall have passive temperature switches for use in the motor control circuit that will limit the winding temperature as defined by NEMA Standard MG1-12.53 Type 1. The contacts shall be normally open and rated to operate a switchgear control relay in either a 250 volt AC (40 VA) or 125 volt DC (12W) control circuit.
4. Coils shall be form wound, vacuum pressure impregnated and compactly shaped to fill the slots. Vacuum pressure impregnation shall be done by treating the entire stator with a minimum of 2 impregnations after the coils are placed in the slots. Winding and end connections shall be fully sealed against contaminants. The stator complete with winding shall be given additional

dips and brakes. Motor end turns shall be adequately braced with nonshrinking material and shall withstand the stress caused by full voltage starting.

5. Motors shall have weather-protected Type I enclosures with top discharge air ventilation openings. Openings shall be equipped with easily removable guard screens. Motors shall have air inlet filters and space heaters.
6. Space heaters shall be 120 volt AC single phase in frame Sizes under 8600. Space heaters shall be 480 volt 3-phase in frame Sizes 8600 and larger. Motors with space heaters shall include heater leads in a separate conduit box mounted on the motor frame. The conduit box shall have an access cover.
7. Motors shall have terminal boxes of adequate size for the construction of the stress cones on the incoming cable and any other connections such as surge and power factor correction capacitors and surge arrestors. Terminal leads shall be minimum of 12 inches long and shall be equipped without lugs. Terminal boxes for motor leads shall have the following minimum dimensions: 20-inch H, 15-inch W, 10-inch D. They shall be diagonally split and furnished undrilled for conduit. The boxes shall be gasketed and suitable for mounting in any direction without allowing water to enter. Each motor shall be equipped with a General Electric Co. or Westinghouse "Surge-Pac," or equal, overvoltage protection. A power factor correcting capacitor shall be provided for full load power factor correction of 0.96 minimum. The Surge-Pac and capacitor shall meet the Specifications of Division 16. The terminal box, Surge-Pac, and power factor correction caps shall be floor-mounted with all connections to the motor housing being made through flexible conduit.
8. Line and thrust bearing shall be of adequate size to take the load of the rotor, together with that of such parts of the shaft not carried by the driven machinery. A suitable base of high-grade cast iron shall be provided for mounting the motor. Adequate provisions must be made at the top of the motor for adjustments to the drive shaft. The motors shall have a protected head cover with a suitable lifting ring or rings.
9. Nameplates shall be metal and be installed with data as required by NEMA and also show locked rotor current and lead connection diagram.
10. The maximum overall noise level shall not exceed the level defined in the latest revision of NEMA Standard MG1-12.49 or MG1-20.49, whichever is applicable to the particular machine.
11. Certified routine shop tests shall be made on one motor out of each size group for motors 1,500 horsepower or smaller. Full running shop tests shall be made on each motor larger than 1,500 horsepower. Test results shall be submitted to CONSTRUCTION MANAGER for CONSTRUCTION MANAGER's record.
12. Provisions for mounting a vibration motor sensor on each motor shall be provided. The mountings for the vibration sensors shall consist of a threaded mounting hole 1/2-20 UNF 2B 0.400-inch minimum depth full threads. Hole shall be located perpendicular, within 0.010-inch/inch, to the centerline of a raised 2.0-inch diameter machined flat surface. Machined surface shall be flat within 0.005 inch. The machined surface is to be located on the upper part of the motor, as close top the thrust bearings as practical and between lifting lugs. The machined surface is to be oriented vertically and parallel plus or minus 3 degrees to the shaft centerline such that the threaded hole is horizontal and perpendicular to the shaft centerline within plus or minus 5 degrees.

2.04 FABRICATION

A. Electric motors shall be shop-finished with 2 coats of enamel paint per manufacturer's recommendations.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Comply with manufacturer's written installation and alignment instructions.

B. Lubricate oil-lubricated bearings.

C. Provide electrical wiring and connections as specified in Division 16 Sections.

3.02 FIELD QUALITY CONTROL

A. Inspect all terminations for proper connection.

B. Check motor for proper rotation.

3.03 INSTALLATION CHECK

A. Installation Check: Manufacturer shall provide the services of a factory-trained representative to check the installation of all equipment installed in this Section. The services shall be as noted in Section 01600. Equipment supplier's representative shall revisit Site as often as necessary until all trouble is corrected and equipment installation and operation is satisfactory to CONSTRUCTION MANAGER.

B. Manufacturer's representative shall provide all necessary tools and testing equipment required including noise level and vibration sensing equipment.

C. Inspection Report: A written report of the installation check shall be submitted to CONSTRUCTION MANAGER. The report shall be as noted under Section 01600 certifying that the equipment:
   1. Has been properly installed and lubricated;
   2. Is in accurate alignment;
   3. Is free from any undue stress imposed by any connection or anchor bolts;
   4. Has been operated under full load condition and that it operated satisfactorily to CONSTRUCTION MANAGER; and
   5. That CONSTRUCTION MANAGER's representative has been instructed in the proper maintenance and operation of the equipment.
   6. Furnish CONSTRUCTION MANAGER a copy of all test data recorded during the installation check including noise level and vibration readings.

HIGH EFFICIENCY MOTOR SCHEDULE NO. 16220.2
MOTOR OPERATING CHARACTERISTICS

		Efficiency (percent)						
		Guar.						
	RPM	Min.		Nominal		Power Factor (percent)		
HP	Syn.	Full	1/2	3/4	Full	1/2	3/4	Full
1	1800	81.5	78.1	81.0	81.5	54.2	67.3	75.8
	1200	75.5	69.5	75.6	78.5	38.4	49.4	58.3
	3600	78.5	78.4	80.2	81.5	75.3	84.4	88.8
1.5	1800	81.5	79.2	82.9	84.0	52.1	65.1	74.0
	1200	81.5	80.5	83.4	84.0	44.0	56.6	85.6
	3600	81.5	78.8	82.9	84.0	66.3	78.4	85.0
2	1800	81.5	78.8	82.6	84.0	48.9	61.7	70.0
	1200	84.0	83.0	83.6	86.5	46.6	59.6	68.0
	3600	84.0	75.4	84.3	86.5	69.7	80.0	85.6
3	1800	86.5	86.9	88.5	88.5	62.3	73.9	79.9
	1200	86.5	84.5	87.5	88.5	45.9	58.3	68.0
	3600	86.5	86.2	88.2	88.5	71.7	81.7	86.4
5	1800	88.5	84.0	88.2	88.5	68.5	79.2	84.6
	1200	86.5	85.8	88.2	88.5	50.8	63.8	71.9
	3600	86.5	82.9	86.7	88.5	75.9	84.3	88.1
7.5	1800	88.5	89.2	90.3	90.2	66.5	77.2	82.4
	1200	86.5	87.5	88.8	88.5	58.6	68.8	73.7
	3600	86.5	87.7	89.0	88.5	77.1	84.5	87.6
10	1800	88.5	89.3	90.4	90.2	67.6	77.4	81.9
	1200	88.5	89.0	90.3	90.2	60.1	70.2	74.9
	3600	88.5	82.3	87.4	90.2	81.1	87.2	90.4
15	1800	90.2	91.0	91.9	91.7	68.5	78.1	82.3
	1200	88.5	89.9	90.6	90.2	67.4	77.1	81.4
	3600	90.2	89.1	91.1	91.7	83.7	88.5	90.5
20	1800	90.2	90.9	91.9	91.7	68.9	78.1	81.8
	1200	90.2	91.0	91.0	91.7	69.8	78.5	81.9
	3600	90.2	91.6	92.0	91.7	81.9	88.6	90.6
25	1800	91.7	92.8	93.2	92.4	72.7	81.4	84.5
	1200	90.2	90.0	91.4	91.7	79.8	84.5	85.5
	3600	90.2	90.6	91.7	91.7	81.1	87.8	90.3
30	1800	91.7	92.8	93.3	93.0	71.5	80.6	84.2
	1200	90.2	91.7	92.0	91.7	78.9	85.4	86.8
	3600	90.2	89.1	91.2	91.7	83.8	88.6	89.9
40	1800	91.7	91.0	92.6	93.0	71.6	80.6	84.2
	1200	91.7	93.0	93.3	93.0	80.9	86.4	88.0
	3600	90.2	88.7	90.8	91.7	82.5	90.8	92.0
50	1800	93.0	92.4	93.7	94.1	76.4	83.7	86.3
	1200	91.7	93.0	93.3	93.0	80.9	87.3	88.9
	3600	91.7	89.9	92.0	93.0	84.9	89.9	91.6
60	1800	93.0	93.2	94.0	94.1	76.3	84.0	86.8
	1200	91.7	92.5	93.1	93.0	75.8	82.9	85.5
	3600	93.0	91.0	93.1	94.1	82.6	88.7	90.9
75	1800	93.0	92.6	93.8	94.1	76.4	83.8	86.6
	1200	93.0	93.5	94.2	94.1	75.1	82.4	84.7
	3600	93.0	91.3	93.3	94.1	86.1	89.7	91.0
100	1800	94.1	93.8	94.8	95.0	83.8	87.6	89.0
	1200	93.0	93.1	93.9	94.1	72.5	80.0	83.2
	3600	93.0	91.2	93.1	94.1	83.0	88.3	89.0
125	1800	93.7	93.5	94.6	95.0	79.2	84.6	86.0
	1200	93.0	93.5	94.2	94.1	75.2	82.3	85.2
	3600	93.0	91.8	93.4	94.1	85.3	89.3	89.1
150	1800	94.1	93.7	94.7	95.0	81.6	86.4	86.6
	1200	94.1	94.1	94.9	95.0	77.2	84.4	85.7
	3600	94.1	92.7	94.3	95.0	83.3	87.5	88.5
200	1800	94.5	94.2	94.9	95.0	80.0	85.6	86.7
	1200	94.3	94.2	94.9	95.0	78.0	84.5	86.0
	3600	94.3	94.8	95.5	95.3	83.0	87.5	88.5
250	1800	94.3	96.0	96.0	95.8	79.5	85.6	83.0

END OF SECTION

SPECIFICATION REVISION INDEX

Revision No.	Revision Date	Issued for	Signatures				
			Prepared By	Reviewed By	Project Engineer	Project Manager	Client
A	11/28/2016	60% Submittal			JG	STD	
B	1/27/2017	DRAFT 90% Submittal			JG	STD	
C	2/15/2017	75% Submittal			JG	STD	

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SECTION 16230

STANDBY DIESEL GENERATOR TRAILER - RENTAL

PART 1 - GENERAL

1.01 SUMMARY

A. The intent of this specification is to provide generator specifications for two (2) rental generators for two (2) separate locations in Henderson Nevada. Generators will provide temporary power on site. No permanent site power will be available for battery charger or coolant heaters. It is the intent that these generators will operate at all times (24 hours a day, 7 days a week) for the duration of the rental.

B. Section Includes: Extent of diesel generator trailer, and is hereby defined to include, but not by way of limitation:

1. Diesel engine.
2. Trailer and Enclosure.
3. Maintenance Agreement and Refueling

C. Types of generator sets required for the Project include:

1. Portable Trailer Mounted Diesel Engine-Driven Generator.

D. Generator and fuel storage tank shall comply with all applicable sections of 2008 NFPA 30 and 2005 NFPA 110.

1.02 SUBMITTALS

A. Shop Drawings: Submit Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:

1. Product Data: Submit manufacturer's data on diesel engine-driven generator sets and components.
   a. Generator trailer dimensions.
   b. Generator trailer weight (wet and dry)
   c. Generator rating.
   d. Exhaust System Data:
      1) Generator Tier Rating
      2) Emissions data.
   e. Fuel system data:
   f. Enclosure Data:
      1) Door locations.

2) Noise reduction.

g. Generator Load Calculations:
   1) Max loading shall be 80%.
   2) Loads shall be on a staged, motors shall be started in sequence, not block loaded during generator start.
   3) Calculation shall be provided via manufacturer's software.

2. Wiring Diagrams: Submit wiring diagrams for diesel engine-driven generator units showing connections to electrical power panels, feeders, and ancillary equipment. Differentiate between portions of wiring that are manufacturer installed and portions that are field installed.
3. Maintenance Agreement: Full Maintenance Agreement package stating that all maintenance will be provided by Generator Provider.

1.03 QUALITY ASSURANCE

A. Codes and Standards:
   1. NFPA Compliance: Comply with applicable requirements of NFPA 37, "Installation and Use of Stationary Combustion Engines and Gas Turbines," NFPA 99, "Standard for Health Care Facilities," and NFPA 101, "Code for Safety to Life from Fire in Buildings and Structures."
   2. UL Compliance: UL 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors," UL 2200, "Standard for Safety for Stationary Engine Generator Assemblies," rated 600 volts or less.
   3. ANSI/NEMA Compliance: Comply with applicable requirements of ANSI/NEMA MG1, "Motors and Generators," and MG2, "Safety and Use of Electric Motors and Generators."
   4. IEEE Compliance: Comply with applicable portions of IEEE Standard 446, "IEEE Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications."

PART 2 - PRODUCTS

2.01 MANUFACTURER / GENERATOR PROVIDER

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
   1. Trailer Diesel Generator Sets:
      a. Caterpillar.
      b. Cummins.
      c. Aggreko.

2.02 GENERATOR SETS

A. The emergency generator set and accessories shall be of a type that complies with the

National Electrical Code and all applicable state and local building codes and shall be UL listed per UL 2200 "Standard for Stationary Engine Generator Assemblies,".

B. A complete engine generator system shall be furnished and installed with fuel transfer pump, base mounted fuel tank, battery, battery charger, muffler, radiator, control panel, and all other accessories required for an operational system.

C. Except as otherwise indicated, provide manufacturer's standard diesel engine-driven generator set and auxiliary equipment as indicated by published product information, and as required for a complete installation. Generator set shall be rated to continuously power the total accumulated load and starting load shown on Schedule at 100 degrees F ambient temperature and at altitude where installed.

D. Diesel Engine: Provide a 4-cycle, compression ignition type engine for operation on a No. 2 domestic burner oil grade of petroleum fuel oil. The engine shall be equipped with fuel, lube oil and intake air filters; lube oil coolers, fuel transfer pump, fuel priming pump, and jacket water heater, 105°C/220°F gear driven water pump. . Engine operating speed shall not exceed 1,800 rpm and shall be controlled by a governor to maintain alternator frequency within plus or minus 3 Hertz of 60 hertz from no load to full load. Frequency shall recover to steady-state tolerance within 5 seconds after application of 90 percent rated load.

E. Generator
   1. The generator shall be a 480 volt, 3-phase, 60 hertz, single bearing, synchronous type, Permanent Magnet Generator (PMG) built to NEMA Standards. Epoxy impregnated Class F insulation shall be used on the stator and the rotor.
   2. The EPA Emissions standard for the generator shall be at minimum Tier 2 rated.

F. Instrument Control Panel: Provide engine-generator unit with engine oil-pressure and water-temperature indicators, reset circuit breaker, static voltage regulator, voltage-adjusting rheostat, voltmeter, ammeter with phase selector switch with an OFF position, and with running time indicator and frequency meters, as required to satisfactory control the engine generator set. Select circuitry of plug-in design capable of quick replacement, and capable of accepting a plug-in device which allows maintenance to test control panel performance without operating the engine.

2.03 TRAILER AND ENCLOSURE

A. A weatherproof sound attenuated type enclosure shall be provided mounted on a trailer to house the engine/generator/fuel tank and accessories. The enclosure shall be designed to perform without overheating in the ambient temperature.

B. The enclosure is to be in complete compliance with the National Electrical Code (NEC), and the National Fire Protection Association (NFPA) with regard to clearances around electrical equipment specified herein. The enclosure shall conform to the following construction and design criteria as set forth:

C. Trailer Dimensions:
   1. Central Water Treatment Plant: Maximum trailer length shall be 50 feet long by 8 feet wide.
   2. Historic Lateral Weir Pump Station: Maximum trailer length shall be 50 feet long by 8 feet wide.

D. As a minimum the enclosure shall provide an average 20dbA sound reduction as measured at 7-meters, 5-feet above grade level under free field conditions.

E. Enclosure shall be waterproof and the roof shall be peaked to allow drainage of rainwater.

F. Unit shall have sufficient guards to prevent entrance by small animals.
   1. Batteries shall be designed to fit inside enclosure and alongside the engine and shall be easily removable for service. Batteries under the generator are not acceptable.

G. Fuel System:
   1. Provide double-wall fuel tank mounted on same trailer as generator. Tank capacity shall be sufficient to run the generator for at least 18 hours at 100 percent capacity of the unit's rated output. The fuel tank shall be furnished with a local fuel site gauge, high and low level alarms, low fuel shutdown and remote fuel level monitoring capability (4-20mA fuel level output). All necessary fuel supply and return lines shall be furnished pre-assembled to unit.

2.04 MAINTENANCE AGREEMENT

A. Service Maintenance
   1. All manufacturer recommended services shall be provided as necessary at recommended intervals by Generator Provider including but not limited to oil changes, coolant changes air and fluid filter replacements etc.
   2. Service Maintenances shall be performed on site at pre-scheduled intervals. Generator Provider shall coordinate with site representative at least 36 hours in advance of when the scheduled maintenance will occur.
   3. Generator maintenance shall be performed with as minimal generator shutdown time as possible up to a maximum of 3 hours. Generator maintenance requiring longer than 3 hours of shutdown time shall be coordinated with the site representative in advance and a backup generator shall be provided to maintain site energization.
   4. Generator Provider must have a local representative able to respond to a generator issue 24 hours a day, 7 days a week. Response to site must be within 2 hours. If issue cannot be resolved within 4 hours a backup generator shall be provided within 8 hours to maintain site energization.

B. Refuel Service
   1. Generator Manufacturer shall be responsible for generator refueling. Fuel shall be provided on a per gallon basis as needed at each of the two sites. Generator Manufacturer shall be responsible for scheduling of fuel delivery with the site representative. Generator Manufacturer shall be responsible to ensure generators do not run out of fuel.

PART 3 - EXECUTION

3.01 INSTALLATION OF DIESEL ENGINE-DRIVEN GENERATOR SETS

A. Generator Provider shall be responsible for delivering generator trailers to site and parking trailer in dedicated generator locations.

B. Generator Provider shall make final connection of conductors to generator load circuit breaker.

C. Generator Provider shall coordinate with on-site Electrician for connection to main distribution panel.

3.02 GROUNDING

A. Generator Provider shall be responsible for providing grounding at site for rental generator per the National Electric Code (NEC) and connection to rental generator. After rental agreement is complete. Generator Provider is required to remove any and all grounding installed for Generator.

TRAILER MOUNTED GENERATOR SCHEDULE – No. 1

Site: Central Water Treatment Plant

Load at starting: One (1) Control Panel (20A, 1-phase).

Load applied after the above starting load is running (subquentially): Three (3) 300 HP pumps with reduces voltage starters. Three (3) 50 HP pumps with Across the line starters. Four (4) 20 HP pumps with Across the line starters. Two (2) 15 HP pumps with Across the line starters. Twelve (12) 10 HP pumps with Across the line starters. Three (3) 5 HP pumps with VFD's. Two (2) 3 HP pumps with VFD's. One (1) distribution power panelboards (200A, 3-phase).

Voltage Starting Type: 480V, 3-phase

Accessories	Required	Remarks
Engine Cooling Radiator	Yes	
Primary Wires	Yes	100 feet
Coolant Heater	Yes	No site voltage.
Enclosure	Yes	
Sound Attenuation	Yes	
Fuel System	Yes	Double Wall

Minimum Generator Size: 1500 kW *

*CONTRACTOR shall verify generator size by providing ENGINEER with calculations via Generator Manufacturer Software. The generator shall be capable of starting the entire load in a single step. Stated minimum does not release CONTRACTOR from successfully completing the load test.

TRAILER MOUNTED GENERATOR SCHEDULE – No. 2

Site: Historic Lateral Weir Pump Station

Load at starting: One (1) Control Panel (20A, 1-phase), One (1) 350 HP pump with Reduced Voltage Soft Starter

Load applied after the above starting load is running (subquentially): Two (2) 350 HP pump with Reduced Voltage Soft Starters. One (1) distribution power panelboard (225A, 3-phase).

Voltage Starting Type: 480V, 3-phase

Accessories	Required	Remarks
Engine Cooling Radiator	Yes	
Primary Wires	Yes	50 feet
Coolant Heater	Yes	No local site power.
Enclosure	Yes	
Sound Attenuation	Yes	
Fuel System	Yes	Double Wall

Minimum Generator Size: 1000 kW *

*CONTRACTOR shall verify generator size by providing ENGINEER with calculations via Generator Manufacturer Software. The generator shall be capable of starting the entire load in a single step.

END OF SECTION

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SECTION 16270

TRANSFORMERS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Types of transformers specified, and include the following:
   1. Dry-type transformers.

1.02 SUBMITTALS

A. Shop Drawings: Submit Drawings covering the items included under this Section. Shop Drawing submittals shall include:
   1. Product Data: Submit manufacturer's technical product data, including rated kVA, frequency, primary and secondary voltages, percent taps, polarity, impedance and average temperature rise above 40 degrees C ambient temperature, sound level in decibels, and standard published data.
   2. Submit manufacturer's Drawings indicating dimensions and weight loadings for transformer installations.
   3. Wiring Diagrams: Submit wiring diagrams for power distribution transformers.

1.03 QUALITY ASSURANCE

A. Codes and Standards:
   1. NEMA Compliance: Comply with NEMA Standard Pub/Nos. ST 20, "Dry-Type Transformers for General Applications," TR 1, and TR 27.
   2. UL Compliance: Comply with applicable portions of ANSI/UL 506, "Safety Standard for Specialty Transformers. Provide power/distribution transformers and components which are UL listed and labeled.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
   1. Acme Electric Corporation.
   2. Cutler-Hammer.
   3. Siemens
   4. Hevi-Duty Electric Div., General Signal Corp.
   5. Square D Company.

2.02 POWER/DISTRIBUTION TRANSFORMERS

A. Except as otherwise indicated, provide manufacturer's standard materials and components as indicated by published product information, designed and constructed as recommended by manufacturer, and as required for complete installation.

B. Dry-Type Distribution Transformers (45 kVA or less): Provide factory assembled, general purpose, air cooled, dry-type distribution transformers where shown; of sizes, characteristics, and rated capacities indicated, single phase, 60 hertz, 10 kV BIL, 4.0 percent impedance, with 480 volts primary and 240/120 volts secondary; or 60 hertz, 10 kV BIL, 4.0 percent impedance with 480-volts delta connection primary and 208/120 volts secondary wye connected. Provide primary winding with 4 taps; 2 to 2-1/2 percent increments above and below full-rated voltage for de-energized tap-changing operation. Insulate with Class 150 or 220 degree C insulation and rate for continuous operation at kVA, and limit transformer temperature rise to maximum of 115 or 150 degrees C, respectively. Provide terminal enclosure, with cover, to accommodate primary and secondary coil wiring connections and electrical supply raceway terminal connector. Equip terminal leads with connectors installed. Limit terminal compartment temperature to 75 degrees C when transformer is operating continuously at rated load with ambient temperature of 40 degrees C. Provide wiring connectors suitable for copper or aluminum wiring. Cushion-mount transformers with external vibration isolation supports; sound-level ratings not to exceed 45 db as determined in accordance with ANSI/NEMA standards. Electrically ground core and coils to transformer enclosure by means of flexible metal grounding strap. Provide transformers with fully enclosed sheet steel enclosures. Apply manufacturer's standard light gray indoor enamel over cleaned and phosphatized steel enclosure. Provide transformers suitable for wall mounting.

C. Finishes: Coat interior and exterior surfaces of transformer, including bolted joints, with manufacturer's standard color baked-on enamel.

D. Provide fully enclosed and encapsulated unit for use in outdoor use in wind driven rain and dust.

PART 3 - EXECUTION

NOT USED

END OF SECTION

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SECTION 16280

TRANSIENT VOLTAGE SURGE SUPPRESSORS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Transient voltage surge suppressors (TVSS) for use on 480 volt, alternating current systems, and motor control center or external mounted applications.

1.02 REFERENCES

A. Underwriters Laboratories Inc. (UL):
   1. 1449 - High Performance Suppression System.
   2. 1283 - High Frequency Extended Range Power Filter.

B. American National Standards Institute (ANSI):
   1. C62.41-91 - Category C3 (Service Entrance).
   2. C62.45-91 - Category C Surge.

1.03 SUBMITTALS

A. Shop Drawings: Include component layout and wiring terminations.

B. Product data.

C. Manufacturer's installation instructions.

D. Operating and maintenance data.

E. Warranties.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer of transient voltage surge suppressor systems for minimum 5 years with satisfactory performance record.

B. Regulatory Requirements: UL rating of Transient voltage surge suppressor shall meet or exceed UL rating of panelboard, motor control center, or other equipment in which suppressor is installed. UL rating of equipment in which suppressor is installed shall not be affected by suppressor.

1.05 SEQUENCING AND SCHEDULING

A. Coordinate with and furnish suppressors to motor control center manufacturer prior to shipment of equipment to site.

1.06 WARRANTY

A. Warrant to correct defective products for minimum 5 years in accordance with manufacturer's standard warranty.

PART 2 PRODUCTS

2.01 TRANSIENT VOLTAGE SURGE SUPPRESSORS

A. Ratings: 277/480 volt grounded wye.

B. Manufacturers: One of the following or equal:
   1. Current Technology, Control Guard Model for motor control center installation or Series IND3000 for external mounting.
   2. EFI, Titan Series.
   3. Leviton, Series 57000.
   4. Lighting and Power Control, equivalent product.
   5. Advanced Protection Technologies, equivalent product.

C. Components:
   1. 30 ampere fused disconnect.
   2. Status indicating pilot lights.
   3. Dry contacts.
   4. NEMA 1 stab-in housing compatible with motor control center specified in Section 16342.

D. Characteristics:
   1. Single Pulse Surge Current Capacity per Phase: 100,000 amperes.
   2. Capacity Per Protection Modes:
      a. L-N Mode: 50,000 amperes.
      b. L-G Mode: 50,000 amperes.
      c. N-G Mode: 50000 amperes.
      d. L-L Mode: 50,000 amperes.
   3. Surge Life Cycle: 1.2 by 50 micro-seconds 20 kilovolt open circuit voltage, 8/20 micro-second waveform 10 kiloamperes short circuit current Category C3 Bi-wave in accordance with ANSI C62.41 and C62.45.
   4. Suppression and Filter Technology: Manufacturer's standard.
   5. Continuous Operating Voltage: Minimum 115 percent of nominal.
   6. Suppression Voltage In Protective Modes: As follows when tested in accordance with UL 1449:
      a. For 480 volt systems:
         1) L-N: 800
      b. For 208 volt systems:
         1) L-N: 500.

7. EMI/RFI High Frequency Noise Power Filter:

Frequency	100 KHz	1 MHz	10 MHz	100 MHz
Attenuation (dB)	34	51	54	48
Attenuation Ratio	50:1	350:1	500:1	250:1

8. Minimum American Wire Gauge Copper in Surge or Noise Suppression Path: Number 6.
9. Field Replaceable Fusing: Current limiting, protecting each pole.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install suppressors in accordance with manufacturer's instructions.

END OF SECTION

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SECTION 16410

CIRCUIT AND MOTOR DISCONNECTS

PART 1 - GENERAL

1.01 SUBMITTALS

A. Shop Drawings: Submit Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
   1. Product data for each type of product specified.

B. Operation and Maintenance Manuals: Submit operation and maintenance manuals for items included under this Section, including circuits and motor disconnects.

1.02 QUALITY ASSURANCE

A. Codes and Standards:
   1. Electrical Component Standards: Provide components which are listed and labeled by UL. Comply with UL Standard 98 and NEMA Standard KS 1.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
   1. Allen-Bradley.
   2. Appleton.
   3. Crouse-Hinds Co.
   4. Cutler-Hammer.
   ~~5.~~ Furnas Electric Co.
   6. Siemens, Inc.
   7. Square D Company.

2.02 CIRCUIT AND MOTOR DISCONNECT SWITCHES

A. Provide NEMA 4 stainless steel enclosure. For motor and motor starter disconnects through 100 horsepower, provide units with horsepower ratings suitable to loads. For motor and motor starter disconnects above 100 horsepower, clearly label switch, "DO NOT OPEN UNDER LOAD."

B. Fusible Switches: (Heavy-duty) switches, with fuses of classes and current ratings indicated. Where current limiting fuses are indicated, provide switches with non-interchangeable feature suitable only for current limiting type fuses.

C. Circuit Breaker Switches: Where individual circuit breakers are required, provide factory-assembled, molded-case circuit breakers with permanent instantaneous magnetic and thermal trips in each pole, and with fault-current limiting protection, ampere ratings as indicated. Construct with overcenter, trip-free, toggle type operating mechanisms with quick-make, quick-break action and positive handle indication. Provide push-to-trip feature for testing and exercising circuit breaker trip mechanism. Construct breakers for mounting and operating in any physical position and in an ambient temperature of 40 degrees C. Provide with AL/CU-rated mechanical screw type removable connector lugs.

D. Non-fusible Disconnects: (Heavy-duty) switches of classes and current ratings as indicated.

2.03 ACCESSORIES

A. Special Enclosure Material: Provide special enclosure material as follows for switches indicated:
   1. Stainless Steel for NEMA 4 switches.

PART 3 - EXECUTION

NOT USED

END OF SECTION

.

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SECTION 16420

MOTOR CONTROLLERS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Types of motor controllers, including:

1. Combination controllers.
2. Fractional HP manual controllers.

1.02 SUBMITTALS

A. Shop Drawings: Submit Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
1. Shop Drawings: Submit Shop Drawings of motor controllers showing dimensions and sizes.
2. Product Data: Submit manufacturer's data and installation instructions on motor controllers.
3. Wiring Diagrams: Submit power and control wiring diagrams for motor controllers, refer to plan sheets for required control schematics.

1.03 QUALITY ASSURANCE

A. Codes and Standards:
1. UL Compliance: Comply with applicable requirements of UL 486A and B, and UL 508, pertaining to installation of motor controllers. Provide controllers and components which are UL listed and labeled.
2. NEMA Compliance: Comply with applicable requirements of NEMA Standards ICS 2, "Industrial Control Devices, Controllers and Assemblies," and Pub No. 250, "Enclosures for Electrical Equipment (1,000 Volts Maximum)," pertaining to motor controllers and enclosures.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
1. Allen-Bradley Co.
2. Crouse-Hinds Co.
3. Cutler-Hammer Products/Eaton Corp.
4. Emotron.
5. ~~5.~~ Furnas Electric Co.
6. Siemens, Inc.
7. Square D Company.

2.02 MOTOR CONTROLLERS

A. Except as otherwise indicated, provide motor controllers and ancillary components which comply with manufacturer's standard materials, design, and construction in accordance with published product information and as required for a complete installation.

B. Combination Controllers: Consist of controller and circuit breaker or fusible or non-fused disconnect switch mounted in common enclosure of types, sizes, ratings, and NEMA sizes indicated. Equip starters with block-type manual reset overload relays. Provide control and pilot devices indicated. Provide 90 degree C SIS or MTW, No. 14 AWG control wiring, tagged at each termination. Provide operating handle for disconnect switch mechanism with indication and control of switch position, with enclosure door either opened or closed, and capable of being locked in OFF position with 3 padlocks. Construct and mount controllers and disconnect switches in single NEMA-type enclosure suitable for the location in which it is installed and fabricated of 316 stainless steel.

1. The 3-phase starter may be the following types:
    a. Full Voltage Non-reversing (FVNR) below 25HP: One 3-pole magnetic contactor with a set of 3 overload devices.
    b. Soft Starts above 20HP

C. Control and Pilot Devices: Provide an individually fused control power transformer in each starter unit. Provide 2 fuses in the transformer primary circuit and 1 in transformer secondary circuit. Size transformers such that they can supply 100VA in excess of the unit requirements or provide 150VA rated transformer, whichever is greater. Provide 300 volt rated, oiltight type pilot lights, push buttons with extended guard and black color insert. Equip stop push buttons with half guard and red color insert. Provide 120/6 volt transformer type push-to-test pilot lights with lens color indicated. Provide machine tool type relays, each with 1 spare N.O. contact. Provide 6-digit elapsed time indicators with one-tenth hour increments. When timers are required, they shall be synchronous type. Indicator lamps shall be LED only. Provide H-O-A switch when indicated with auxiliary contacts as indicated and terminal blocks for all required I/O.

D. Fractional HP Manual Controllers: Provide 3-phase and single-phase fractional horsepower manual motor controllers, of sizes and ratings indicated. Equip with manually operated quick-make, quick-break toggle mechanisms, and with one-piece melting alloy type thermal units. Controller shall become inoperative when thermal unit is removed. Provide controllers with double-break silver alloy contacts, visible from both sides of controller, and switch capable of being padlocked-OFF. Enclose controller unit in NEMA-type enclosure suitable for the location in which it is installed; coat with manufacturer's standard color finish.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Install only with stainless steel strut, fasteners and fittings and either stainless steel or precast concrete posts.

END OF SECTION

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SECTION 16440

PANELBOARDS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes the following:

1. Power distribution panelboards.

1.02 SUBMITTALS

A. Shop Drawings: Submit Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
1. Manufacturer's product data on panelboards and enclosures.

1.03 QUALITY ASSURANCE

A. Codes and Standards:
1. UL Compliance: Comply with applicable requirements of UL 67, "Electric Panelboards," and UL's 50, 869, 486A, 486B, and 1053 pertaining to panelboards, accessories, and enclosures. Provide panelboard units which are UL listed and labeled.
2. NEMA Compliance: Comply with NEMA Standards Pub/No. 250, "Enclosures for Electrical Equipment (1,000 Volts Maximum)," Pub/No. PB 1, "Panelboards," and Pub/No. PB 1.1, "Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less."
3. Federal Specification Compliance: Comply with FS W-P-115, "Power Distribution Panel," pertaining to panelboards and accessories.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
1. Cutler-Hammer Products.
2. Siemens, Inc.
3. Square D Company.

2.02 PANELBOARDS

A. Except as otherwise indicated, provide panelboards, enclosures, and ancillary components, of types, sizes, and ratings indicated, which comply with manufacturer's standard materials; with design and construction in accordance with published product information. Equip with proper number of unit panelboard devices as required for complete installation. Where types, sizes, or ratings are not indicated, comply with NEC, UL, and established industry standards for those applications indicated.

B. Power Distribution Panelboards: Provide dead-front safety type power distribution panelboards as indicated, with panelboard switching and protective devices in quantities, ratings, and types shown; with anti-turn solderless pressure type main lug connectors approved for use with copper conductors. Select unit with feeders connecting at top of panel. Equip with tin-plated aluminum, or silver- or tin-plated copper bus bars braced for 65,000 rms symmetrical amperes fault current, and with full-sized neutral bus; provide suitable lugs on neutral bus for outgoing feeders requiring neutral connections. Provide molded-case bolt-on main and branch circuit breakers for each circuit with toggle handles that indicate when tripped. Where multiple pole breakers are indicated, provide with common trip so overload on one pole will trip all poles simultaneously. Provide panelboards with bare uninsulated grounding bars suitable for bolting to enclosures. Select enclosures fabricated by same manufacturer as panelboards, which mate and match properly with panelboards.

C. Panelboard Enclosures: Provide 316 stainless steel cabinet type enclosures, in sizes and NEMA types as indicated, code gauge, minimum 16-gauge thickness. Construct with multiple knockouts and wiring gutters. Provide hinged cover fronts, NEMA 4X rated with operable three point handle. Equip with interior circuit directory frame and card with clear plastic covering. Provide baked gray enamel finish interior steel panels over a rust-inhibitor coating. Design enclosures for surface mounting. Provide enclosures which are fabricated by same manufacturer as panelboards, which mate and match properly with panelboards to be enclosed.

D. Molded-Case Circuit Breakers: Provide factory assembled, molded-case circuit breakers of frame sizes, characteristics, and ratings, including rms symmetrical interrupting ratings indicated. Select breakers with permanent thermal and instantaneous magnetic trip, and with fault-current limiting protection, ampere ratings as indicated. Construct with overcenter, trip-free, toggle type operating mechanisms with quick-make quick-break action and positive handle trip indication. Construct breakers for mounting and operating in any physical position, and operating in an ambient temperature of 40 degrees C. Provide breakers with mechanical screw type removable connector lugs, AL/CU rated.

E. Ground Fault Protected Breakers: All breakers shall be GFI. Provide UL Class A protected GFI breakers with 6 mA for personnel protection, and for general-purpose receptacles. For breakers dedicated to equipment (mixers, pumps, heat trace, etc.), provide breaker with 30 mA equipment protection.

F. Accessories: Provide panelboard accessories and devices including, but not necessarily limited to, ground-fault protection units or circuit breaker locking hardware as indicated.

G. Spares: Refer to panel schedules on plan sheets.

PART 3 - EXECUTION

3.01 INSTALLATION OF PANELBOARDS

A. Type out panelboard's circuit directory card upon completion of installation Work.

END OF SECTION

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SECTION 16503

POLES AND STANDARDS

PART 1 - GENERAL

1.01 SUMMARY

A. Exterior lighting fixtures (luminaires) and brackets, which are required in connection with electrical poles and standards, are specified in Section 16510.
B. Exterior poles for overhead aerial cable support.

1.02 SUBMITTALS

A. Shop Drawings: Submit Shop Drawings covering items included under this Section. Shop Drawing submittals shall include:
   1. Shop Drawings of electrical poles and standards, including mast arms and wire/cable connections which are custom work.
   2. Product Data: Submit manufacturer’s data on electrical poles, standards, and hardware. Include poles, standards, and mast arms, if any.

1.03 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of equipment, of types and sizes required, and whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards:
   1. UL Compliance: Comply with UL Standards, including UL 486A and B pertaining to electrical poles and standards. Provide lighting components and fittings which are UL listed and labeled.
   2. ANSI/ASTM Compliance: Comply with applicable requirements of ANSI C 2, "National Electrical Safety Code," and O 5.1, "Specifications and Dimensions for Wood Poles," pertaining to construction and installation of lighting poles and standards.
   3. FS Compliance: Comply with FS TT-W-571 I and J pertaining to wood preservation treating practices.
   4. AWPA Compliance: Comply with provisions of applicable American Wood-Preservers Association standards pertaining to preservative treatment of wood poles and standards.
   5. AASHTO Compliance: Comply with applicable requirements of American Association of State Highway and Transportation Officials Standard LTS-1, "Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals."
   6. NEMA Compliance: Comply with NEMA Standards Pub/No's. LE 2 and TT 1 pertaining to electrical pole and standard units, materials, and installation.
   7. IES Compliance: Comply with applicable requirements of IES RP-8, "Roadway Lighting," and RP-20, "Parking Facilities Lighting."

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering electrical poles and standards which may be incorporated in Work include:
   1. Wood Poles:
      a. Crown Zellerback Corp.
      b. Georgia-Pacific Corp.
      c. Idaho Pole Co.
      d. MacGillis and Gibbs Co.
      e. Niedermeyer-Martin Co.
      f. Omega Industries, Inc.
      g. Southern Wood Preserving Co.
      h. St. Regis Paper Co.
   2. Standards:
      a. Appleton Electric Co.
      b. General Electric Co.
      c. Kirlin Company.
      d. Koppers Company.
      e. Lexington Standard Corp.
      f. Lighting Division, Harvey Hubbell, Inc.
      g. Spring City Electrical Mfg. Co.
      h. Sternberg Lanterns, Inc.
      i. Union Metal Mfg. Co.
      j. Westinghouse Electric Corp.

2.02 ELECTRICAL POLES AND STANDARDS

A. Design standards to sustain wind velocities up to 90 miles per hour with a gust factor of 1.3, to withstand a 0.5-inch ice covering on horizontal surfaces at basic wind velocity, and to accommodate luminaire weight.

B. Utility-Type Wood Power Distribution and Lighting Poles: Provide utility-type tapered solid wood poles of sizes and type materials indicated; pressure-treat with creosote solution preservative.

   1. Wood Pole Accessories: Where indicated, provide wood pole accessories, including guy-wires, anchors, and eyebolts, of types recommended by wood pole manufacturer, of sizes and materials needed to fulfill loading erection application requirements.

PART 3 - EXECUTION

3.01 INSTALLATION OF WOOD POLES

A. Prior to installation, provide dig plan in compliance with NERT requirements. Avoid known contaminated areas.

END OF SECTION

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SECTION 16510

LIGHTING FIXTURES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Types of lighting fixtures, including:

1. High-intensity Discharge (HID):
   a. Metal halide.
2. Fluorescent.
3. LED

B. Applications of lighting fixtures required for this Project include:
   1. Exterior lighting.

1.02 SUBMITTALS

A. Shop Drawings: Submit Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
   1. Product Data: Submit manufacturer's product data and installation instructions on each type lighting fixture and component. Assemble in booklet form with separate sheet for each fixture, assembled in "luminaire type" alphabetical or numerical order, with proposed fixture and accessories clearly indicated on each sheet. Indicate voltage, bulb type, and wattage.
   2. Illumination Data: Provide isofootcandle (isolux) plot diagram of footcandles on horizontal pavement surface which shows values of illuminance projected from indicated fixture heights for area lighting.

B. Operation and Maintenance Manuals: submit in operation and maintenance manuals for items included under this Section. Include maintenance data and parts list for each lighting fixture and accessory, and troubleshooting maintenance guide

1.03 QUALITY ASSURANCE

A. Manufacturer’s Qualifications: Firms regularly engaged in manufacture of equipment, of types and sizes required, and whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards:
   1. NEMA Compliance: Comply with applicable requirements of NEMA Standards Pub/No. LE 2 pertaining lighting equipment.
   2. IES Compliance: Comply with IES RP-8, 19, 20, and PB-15 pertaining to exterior, parking, and roadway lighting practices and fixtures.
   3. UL Compliance: Comply with requirements of UL standards, including Standards 486A and B, pertaining to lighting fixtures. Provide lighting fixtures and components which are UL listed and labeled.

4. NFPA Compliance: Comply with applicable requirements of NFPA 780, "Lightning Protection Code," pertaining to installation of exterior lighting fixtures.
5. CBM Labels: Provide fluorescent lamp ballasts which comply with Certified Ballast Manufacturers Association standards and carry the CBM label.
6. LED Drivers: Drivers shall be UL listed and shall have a minimum rating equall to the total required wattage of the LED's.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
   1. Lighting Fixtures:
      a. See Luminaire Schedules on Drawings.
   2. Fluorescent Ballasts:
      a. Advance Transformer Co.
      b. TRIAD-UTRAD Division, Litton Industries, Inc.
      c. Universal Mfg. Co.
   3. High-Intensity Ballasts:
      a. Advance Transformer Co.
      b. Holophane Div.; Johns-Manville Corp.
      c. Jefferson Electric Co.
      d. McGraw-Edison Co.
      e. Sola Electric Division, General Signal Corp.
      f. U.S. Lighting Products, Inc.
      g. Wide-Lite Corp.
   4. LED Drivers:
      a. Cree
      b. AC Electronics

2.02 EXTERIOR LIGHTING FIXTURES

A. Provide lighting fixtures of sizes, types, and ratings indicated on Luminaire Schedule on Drawings, complete with, but not limited to, housings, energy efficient ballasts, starters, and wiring.
   1. Fluorescent Lamp Ballasts: Provide low-temperature, high power-factor, low-energy fluorescent lamp ballasts capable of operating lamp types indicated. Provide in-line fuse holders using replaceable fuses in each fixture.

   2. High-Intensity Discharge Lamp Ballasts: Provide HID lamp ballasts capable of operating lamp types and ratings indicated over a plus 10 percent voltage variation; high power-factor regulator or auto-regulator constant wattage, core and coil assembly encapsulated in nonmelt resin; install capacitor outside ballast encapsulation for easy field replacement. Provide in-line, watertight fuse holders with replaceable fuses rated 300 volt or 600 volt as required.

   3. Lamps:
      a. Provide clear metal halide in wattages indicated.
      b. LED: Cree 4000Kelvin

2.03 EXTRA MATERIALS

A. Extra Stock: Furnish stock of replacement lamps and drivers amounting to 15 percent (but not less than 1 in each case) of each type and size used in each type fixture. Deliver replacement stock as directed to CONSTRUCTION MANAGER's storage space and obtain receipt.

PART 3 - EXECUTION

3.01 INSTALLATION OF LIGHTING FIXTURES

A. Install lighting fixtures at locations and heights as indicated, in accordance with fixture manufacturer's written instructions, applicable requirements of NEC, NECA's "Standard of Installation," NEMA standards, and with recognized industry practices to ensure that lighting fixtures fulfill requirements. Field locate fixtures to avoid conflicts with equipment, pipework, etc.

END OF SECTION