

SAUSALITO-MARIN CITY SANITARY DISTRICT
SOUTH PRIMARY CLARIFIER REHABILITATION PROJECT
SAUSALITO, CALIFORNIA
SEPTEMBER 2023

TABLE OF CONTENTS

VOLUME 2 OF 3

TECHNICAL SPECIFICATIONS



8/25/23

VOLUME 1

BIDDING DOCUMENTS

SECTION NO.	TITLE
00100	NOTICE INVITING BIDS
00200	INSTRUCTIONS TO BIDDERS
00210	ACCESS, INDEMNITY AND RELEASE AGREEMENT
00300	SUPPLEMENTAL PROJECT INFORMATION AVAILABLE TO BIDDERS
00400	BID FORM
00500	NOTICE OF AWARD
00510	AGREEMENT
00515	CORPORATE CERTIFICATE OF AUTHORIZATION
00520	PARTNERSHIP CERTIFICATE OF AUTHORIZATION
00525	JOINT VENTURE CERTIFICATE OF AUTHORIZATION
00530	LLC CERTIFICATE OF AUTHORIZATION
00540	PERFORMANCE BOND
00550	PAYMENT BOND
00560	CONTRACTORS WORKERS COMP CERTIFICATION
00600	NOTICE TO PROCEED
00610	SAMPLE ESCROW AGREEMENT
00700	GENERAL CONDITIONS
00800	SUPPLEMENTARY GENERAL CONDITIONS

DIVISION 01 - GENERAL REQUIREMENTS

SECTION NO.	TITLE
01060	REGULATORY REQUIREMENTS AND PERMITS
01110	SUMMARY OF WORK
01140	WORK RESTRICTIONS
01160	SITE SAFETY REQUIREMENTS
01200	MEASUREMENT AND PAYMENT
01312	PROJECT MEETINGS
01322	WEB BASED CONSTRUCTION DOCUMENT MANAGEMENT
01324	PROGRESS SCHEDULES AND REPORTS

01326	PHOTOGRAPHIC AND VIDEOGRAPHIC DOCUMENTATION
01330	SUBMITTAL PROCEDURES
01340	REQUEST FOR INTERPRETATION
01353	SPECIAL PROCEDURES FOR LOCATING AND VERIFYING CONCEALED EXISTING UTILITIES
01354	HAZARDOUS MATERIAL PROCEDURES
01355	STORMWATER POLLUTION PREVENTION CONSTRUCTION ACTIVITIES: BEST MANAGEMENT PRACTICES
01410	REGULATORY REQUIREMENTS
01424	ABBREVIATIONS
01450	QUALITY CONTROL AND INSPECTIONS
01455	SPECIAL TESTS AND INSPECTIONS
01460	CONTRACTOR QUALITY CONTROL PLAN
01500	CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS
01550	TRAFFIC CONTROL
01560	ENVIRONMENTAL CONTROLS
01600	PRODUCT REQUIREMENTS
01605	DELIVERY, STORAGE, AND HANDLING
01612	SEISMIC DESIGN CRITERIA
01722	FIELD ENGINEERING
01734	WORK WITHIN PUBLIC RIGHT-OF-WAY
01738	SELECTIVE ALTERATIONS AND DEMOLITION
01745	SPARE PARTS, SPECIAL TOOLS AND MAINTENANCE MATERIALS
01756	FACILITY START-UP
01759	WATER LEAKAGE TEST FOR CONCRETE STRUCTURES
01770	CONTRACT CLOSEOUT
01780	RECORD DOCUMENTS
01782	OPERATING AND MAINTENANCE DATA
01785	WARRANTIES AND BONDS
01999	REFERENCE FORMS

VOLUME 2

DIVISION 02 - SITEWORK

SECTION NO.	TITLE
02050	DEMOLITION & RECONSTRUCTION
02620	HYDRAULIC STRUCTURE TESTING AND DISINFECTION
02640	PIPELINE TESTING AND DISINFECTION

DIVISION 03 - CONCRETE

SECTION NO.	TITLE
03100	CONCRETE FORMWORK
03150	CONCRETE JOINTS AND JOINT ACCESSORIES
03200	CONCRETE REINFORCEMENT
03300	CAST-IN-PLACE CONCRETE

03600 GROUT

DIVISION 04 - MASONRY

DIVISION 05 - METALS

SECTION NO.	TITLE
05120	STRUCTURAL STEEL
05500	MISCELLANEOUS METALS
05510	METAL STAIRS
05520	ALUMINUM HANDRAILS AND GUARDRAILS

DIVISION 06 - WOODS AND PLASTICS

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

DIVISION 08 - DOORS AND WINDOWS

DIVISION 09 - FINISHES

SECTION NO.	TITLE
09960	PROTECTIVE COATINGS

DIVISION 10 - SPECIALTIES

SECTION NO.	TITLE
10400	IDENTIFYING DEVICES

DIVISION 11 - EQUIPMENT

SECTION NO.	TITLE
11000	EQUIPMENT GENERAL PROVISIONS
11052	AUTOMATED REFRIGERATED SAMPLERS
11100	PUMPS, GENERAL
11147	DOUBLE DISC PUMPS
11231	CIRCULAR, CENTER-FEED CLARIFIERS

DIVISION 12 - FURNISHINGS

DIVISION 13 - SPECIAL CONSTRUCTION

SECTION NO.	TITLE
13130	FLAT CIRCULAR CLARIFIER COVERS
13400	INSTRUMENTATION AND CONTROL SYSTEM
13470	SCADA PLC SYSTEM
13475	CONTROL STRATEGIES

DIVISION 14 - CONVEYING SYSTEMS

DIVISION 15 - MECHANICAL

SECTION NO.	TITLE
15000	PIPING, GENERAL
15005	PIPING IDENTIFICATION SYSTEMS
15006	PIPE SUPPORTS
15036	COPPER PIPE
15060	POLYVINYL CHLORIDE SOLVENT-WELDED PIPE
15180	STRAINERS
15200	VALVES, GENERAL
15201	VALVE AND GATE ACTUATORS
15203	CHECK VALVES
15214	PRESSURE CONTROL VALVES
15230	MISC VALVES
15250	HYDRAULIC GATES
15430	PLUMBING AND PIPING
15870	FIBERGLASS REINFORCED PLASTIC (FRP) DUCTING
15954	HVAC SYSTEMS TESTING, ADJUSTING, AND BALANCING

DIVISION 16 - ELECTRICAL

SECTION NO.	TITLE
16000	REQUIREMENTS FOR ELECTRICAL WORK
16025	ELECTRICAL DEMOLITIONS AND MODIFICATIONS
16075	ELECTRICAL IDENTIFICATION
16222	MOTORS
16422	MOTOR CONTROL
16920	600 V MOTOR CONTROL CENTER
16950	ELECTRICAL TESTING

SECTION 02050 – DEMOLITION & RECONSTRUCTION

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall furnish all materials, supplies, tools, equipment, and labor as required for the reconstruction of all or portions of existing civil, landscaping, structural, architectural, mechanical, HVAC, electrical, and instrumentation facilities as specified herein and/or shown on the Drawings.
- B. Reconstruction shall include, but shall not be limited to, the following items:
 - 1. Demolition
 - 2. Salvage
 - 3. Relocation
 - 4. Abandonment
 - 5. Rehabilitation
 - 6. Disposal
- C. Related Work Specified Elsewhere
 - 1. Section 01110 - Summary of Work
 - 2. Section 01330 – Submittal Procedures
- D. The Contractor shall carefully coordinate the reconstruction in areas where existing facilities are interconnected with new facilities and where existing facilities shall remain operational. The reconstruction specified and shown in the Contract Documents is not all inclusive and the Contractor shall be responsible to perform the reconstruction specified, shown, or which can be reasonably inferred from the Contract Documents as necessary to complete the Project. The Specifications and Drawings identify the major facilities that shall be reconstructed, but auxiliary utilities such as water, air, chemicals, drainage, lubrication, fluid power, electrical wiring, controls, and instrumentation are not necessarily shown. The Contractor shall comply with Project and operational sequencing requirements specified in Section 01010 - Summary of Work.
- E. The Contractor shall note that the Drawings used in this Contract to indicate reconstruction are based on design drawings for the existing facilities. The plans and sections depicted in the Contract Documents have been reproduced to show existing conditions and to clarify the scope of work as much as possible. Prior to bidding, the Contractor shall conduct a comprehensive survey at the Project Site of the facilities to verify the correctness and exactness of the Drawings, the scope of work, and the extent of auxiliary utilities. A set of design drawings is available for review at the Project site.

- F. While reconstruction is being performed, the Contractor shall provide adequate access for the continued operation and maintenance of equipment and treatment processes. The Contractor shall erect and maintain fences, warning signs, barricades, and other devices as required for the protection of the Contractor's employees and the Owner's personnel at the plant. The Contractor shall remove all such protection when reconstruction activities are complete, or as work progresses, or when directed by the Engineer.

1.2 CONTRACTOR SUBMITTALS

- A. Reconstruction activities and procedures, including operation sequence, shall be submitted to the Engineer for approval. The procedures shall provide for safe conduct of the Work, careful removal and disposition of materials and equipment, protection of existing facilities that are to remain undisturbed, coordination with existing facilities to remain in service, and timely disconnection of utility service. The storage plan for all salvaged items shall be included. The procedures shall include a detailed description and time schedule of the methods and equipment to be used for each operation and the sequence of operation. Submittals shall be in accordance with Section 01330 – Submittal Procedures.

- B. The Contractor shall prepare and submit for review by the Engineer a *Demolition and Relocation Plan* for each area of the Project (clarifier, pump stations, effluent box) to detail the utilities, piping and appurtenances that are known to be or may be impacted by the Contractor's activities.

- 1. All utilities within the work area shall be identified by the Contractor and such utilities shall be designated as follows:

- a. Active Utilities (Utilities Confirmed to be Currently in Service)

- 1) Active Utility To Remain in Service During Construction
 - a) Definition: Utility will not be impacted at any point during construction and will be protected in place.
- 2) Active Utility to be Bypassed During Construction
 - a) Definition: All or a portion of the utility will be bypassed during construction.
 - b) Contractor shall identify the points for bypass connection and the proposed route and means for temporary bypass.
- 3) Active Utilities to be Temporarily Disconnected
 - a) Definition: All or a portion of the utility will be disconnected for some portion of the construction, with no means to bypass the disconnected segment(s). Utility will be replaced, in kind, at existing location.
 - b) Contractor shall identify the points of disconnection and means of isolating the disconnected segment(s).
- 4) Active Utilities to be Relocated
 - a) Definition: All or a portion of the utility will be removed and replaced, in kind, at a different location

to place the utility in a location unaffected by construction.

- b) Contractor shall identify the points of disconnection and means of isolating the disconnected segment(s).
- c) Contractor shall identify the proposed alignment/location for relocation, coordinating with new facilities to be constructed as a part of this Project.

b. Inactive Utilities (Utilities Confirmed Not Currently in Service)

1) Inactive Utilities Required for Future Operation

- a) Definition: Though not currently in service, District will require that the utility be protected in place or relocated for potential future use.
- b) Contractor shall document these Inactive Utilities similar to as indicated for Active Utilities. These utilities may require relocation.

2) Inactive Utilities Not Required for Future Operation

- a) Definition: Utility is not currently active and District does not require utility for future use. Such utilities, will be removed from the Project Area.
- b) Contractor shall identify the points of removal and means of isolating the disconnected segment(s).

- 2. Not all utilities within the Project Area are marked, and the existing status may not be apparent by observation. To confirm the current status of all utilities, Contractor shall be required to conduct site investigations and consult with District Operators, incorporating findings into the Demolition and Relocation Plan.
- 3. Active utilities to remain in service or be temporarily bypassed shall be removed from service for the shortest possible period of time. An Outage request will be required for disruption of any active utility.
- 4. Contractor shall not cut or demolish any existing utility without a Demolition and Relocation Plan approved by the Engineer.

PART 2 PRODUCTS

2.1 GENERAL

- A. Demolition: Existing pavement, structures, equipment, piping, valves, ductwork, electrical gear, instrumentation, utilities, and related appurtenances such as anchors, supports, and hardware shown or required to be demolished as part of the Work shall be removed and disposed of by the Contractor unless otherwise indicated. Removal of buried structures, utilities, and appurtenances includes the related excavation and backfill as required. Items to be removed shall be disposed of offsite by the Contractor as part of the Work.
- B. Salvage: Items of existing equipment, piping, valves, electrical gear, instrumentation, utilities, and appurtenances shown to be salvaged shall be

removed by the Contractor. Materials and equipment to be salvaged shall be removed in a manner that maintains them in a condition equivalent to their condition prior to being removed. Salvaged items shall be stockpiled and protected on the jobsite by the Contractor at a location directed by the Engineer. The Contractor shall be responsible to properly safeguard the salvaged items against damage and loss during removal and handling. The Contractor shall coordinate with the Owner during construction with regard to equipment to be salvaged.

- C. Relocation: Items of existing equipment, piping, valves, electrical gear, instrumentation, utilities, and appurtenances shown to be relocated shall be removed and reinstalled by the Contractor. Materials and equipment to be relocated shall be removed in a manner that maintains them in a condition equivalent to their condition prior to being removed. The Contractor shall be responsible to properly safeguard the relocated items against damage and loss during removal, handling, storage, and installation in the new location.
- D. Abandonment: Items of existing equipment, piping, valves, electrical gear, instrumentation, utilities, and appurtenances shown to be abandoned in place shall be protected from damage as specified herein and shown on the Drawings. Pipelines that are to be cut and abandoned in place shall be properly capped unless otherwise indicated.
- E. Remove: "Remove" shall be defined as "Demolition" and "Disposal" by the Contractors unless other with noted.
- F. Rehabilitation
 - 1. Existing civil, landscaping, structural, architectural, mechanical, HVAC, electrical, and instrumentation work disturbed or damaged by reconstruction activities shall be repaired and rehabilitated as specified herein and shown on the Drawings at the Contractor's expense.
 - 2. Damaged items shall be repaired or replaced with new materials as required to restore damaged items of surfaces to a condition equal to and matching that existing prior to damage or start of work of this Contract.
 - 3. In buildings with reconstruction work, the Contractor shall not use any Owner equipment (e.g., bridge cranes and monorails) unless authorized in advance in writing by the Engineer. Such authorization shall be subject to documentation by the Contractor of the loading he proposes to place on the equipment and subject to Owner requirements for crane use for operating and maintenance needs. Any damage sustained in the use of a crane by the Contractor shall be repaired or replaced at no cost to the Owner. The damaged unit shall be repaired or replaced as described above.
- G. Disposal: The Contractor shall be responsible for the offsite disposal of all debris resulting from reconstruction in compliance with all local, state, and federal codes and requirements. Debris resulting from reconstruction includes, but is not limited to, all concrete masonry, metals, asphalt, equipment, liquids that are required to be drained, solids that require removal, wires, cables, conduits, and miscellaneous material resulting from demolition, salvage, relocation, abandonment, and rehabilitation activities and procedures.

PART 3 EXECUTION

3.1 GENERAL

- A. The Contractor shall be responsible for the coordination of reconstruction work with the Owner and Engineer. Unless otherwise specified or shown, the Contractor shall be responsible for the sequence of reconstruction activities. All reconstruction shall be performed in accordance with applicable safety rules and regulations.
- B. The Contractor shall ensure that any utilities connected to structures, equipment, and facilities to be removed, relocated, salvaged, replaced, or abandoned shall be inoperable, replaced with new utilities, or adequately bypassed with temporary utilities before proceeding with reconstruction.
- C. The Contractor shall take precautions to avoid damage to adjacent facilities and to limit the reconstruction activities to the extent specified and shown. If reconstruction beyond the scope specified or shown is required, the Contractor shall obtain written approval from the Engineer prior to commencing work.
- D. Explosives shall not be permitted for demolition.

3.2 INSTALLATION

A. Protection of Existing Facilities

- 1. Before beginning any reconstruction work, the Contractor shall carefully survey the existing facilities and examine the Specifications and Drawings to determine the extent of reconstruction and coordination with the Work. Existing facilities not subject to reconstruction shall be protected and maintained. Damage to existing facilities shall be repaired or replaced to its existing condition at no additional cost to the Owner.
- 2. Contractor shall ensure the safe passage of persons around area of demolition.
- 3. The existing elevated causeway next to the existing primary clarifier, along the shoreline, has a weight limitation of 250 pounds per square foot, maximum.
- 4. The Contractor shall ensure that structural elements are not overloaded and shall be responsible for shoring, bracing, or adding new supports as may be required to ensure adequate structural support as a result of any reconstruction work performed under any part of this Contract. The Contractor shall remove all temporary protection when the Work is complete or when so authorized by the Engineer.
- 5. The Contractor shall carefully consider all bearing loads and capacities for placement of equipment and material on Site. In the event of any questions as to whether an area to be loaded has adequate bearing capacity, the Contractor shall consult with the Engineer prior to the placement of such equipment of material.

B. Demolition, Salvage, Relocation

1. The Contract drawings identify existing facilities to be demolished, salvaged, and/or relocated. Auxiliary utility services such as water, air, chemicals, drainage, lubrication, fluid power, electrical wiring, controls, and instrumentation are not necessarily indicated or shown. The Contractor shall verify the scope of the work to remove the equipment indicated; coordinate its shutdown, removal, replacement, or relocation; and submit an outage plan in accordance with Section 01300 - Submittals. The removal of existing facilities for demolition, salvage, and relocation shall include, but not be limited to, the following requirements at no addition cost to the Owner:
 - a. All equipment supports, including concrete pads, baseplates, mounting bolts, and support hangers, shall be removed. Any damage to the existing structure shall be repaired as specified.
 - b. All exposed piping (including vents and drains) and valves shall be removed. Where exposed piping penetrates existing floors and walls, the piping, including wall thimbles, shall be removed to a minimum depth of 2 inches. All resulting openings in the structure shall be repaired as specified herein.
 - c. All electrical control panels, junction boxes, motor control centers, and local switches and pushbuttons shall be removed.
 - d. All exposed electrical conduits and associated wiring shall be removed. All resulting openings in structures shall be repaired as specified herein.
 - e. Embedded electrical conduits shall be removed a minimum of 2 inches from the finished surface of the existing structure. All wiring shall be removed within the existing structure and the resulting openings shall be repaired as specified herein.
 - f. All associated instrumentation devices shall be removed.
 - g. All auxiliary utility support systems shall be removed.
 - h. The area shall be thoroughly cleaned such that little or no evidence of the previous equipment installation will remain.
2. Asphalt and concrete pavement, curbs and gutters shall be removed as necessary to perform construction. The limits of removal shall be saw cut in neat clean lines. When the required improvements have been constructed, new asphalt and concrete pavement, curbs, and gutters shall be replaced to match the original unless otherwise specified or shown.
3. Footings, foundation walls, below-grade construction and concrete slabs on grade shall be demolished and removed to a depth that will not interfere with new construction, but not less than 36 inches below existing ground surface or future ground surface, whichever is lower, unless otherwise stated in this Section or shown on the Drawings.
4. Below-grade areas and voids resulting from demolition of pipes and structures shall be completely filled. All fill and compaction shall be in accordance with Section 02200 – Earthwork. After fill and compaction, surfaces shall be graded to meet adjacent contours and to provide flow to surface drainage structures, or as shown.
5. When existing pipe is cut or removed, the Contractor shall plug or cap all resulting open ends whether or not shown. Where remaining piping is exposed, the remaining piping shall be blind-flanged or fitted with a

removable cap or plug. If the existing piping is to remain in service, all blind flanges, plugs, and/or caps shall be gasketed where applicable and leak tight for the existing pipes service conditions. The Contractor shall use fittings that are specifically designed for the existing pipe. Contractor shall provide thrust protection as required.

6. When existing piping is removed from existing structures, the Contractor shall fill in resulting openings in the structures and repair any damage such that the finished rehabilitated structure shall appear as a new homogeneous unit with little or no indication of where the new and old materials join. The openings in water-bearing structures shall be filled with non-shrink grout to be watertight and reinforced as required or shown to prevent leakage from the structure for the service conditions of the structure. In all locations where the surface of the grout will be exposed to view, the non-shrink grout shall be recessed to approximately 1/2-inch from the exposed surface and the recessed area filled with cement mortar grout.
7. All electrical reconstruction shall be conducted by the Contractor in a safe and proper manner at all times to avoid injury from electrical shock to the Owner's and Contractor's personnel. Prior to electrical reconstruction, the Contractor shall notify the Owner in writing a minimum of 5 days prior to requested de-energization. The Owner shall de-energize and safe-out the equipment. Both the Contractor and Owner shall use lock-out/tag-out procedures on equipment. Electrical equipment to be shut off for a period of time shall be tagged, locked out, and sealed with a crimped wire and lead seal and made inoperable. At no time shall live electrical wiring or connections or those which can become energized be accessible to Contractor, Owner, or other personnel without suitable protection or warning signs.
8. The Contractor shall perform a functional test of existing equipment that is relocated and reinstalled to ensure the equipment functions in the manner documented during initial inspection. The Contractor shall inform the Engineer in writing a minimum of 5 days prior to the functional testing in order for the Owner and Engineer to witness the test. If, in the opinion of the Engineer, the relocated equipment does not function in a satisfactory manner, the Contractor shall make repairs and modifications necessary to restore the equipment to its operating condition immediately prior to relocation at no expense to the Owner.

C. Abandonment

1. Existing facilities to be abandoned shall be prepared as specified herein or shown on the Drawings. Where existing buried piping is to be abandoned, the Contractor shall remove the abandoned pipe for a distance of 5 feet from any connecting structures unless otherwise noted on the drawings. All openings at the existing structures shall be repaired. The remaining pipe shall be capped at both ends prior to backfill. Buried piping, 12-inch diameter or greater, shall be completely sand-filled prior to closure of the piping ends.

D. Rehabilitation

1. Certain areas of existing structures, piping, conduits, and the like will be affected by work necessary to complete modifications under this Contract. The Contractor shall be responsible to rehabilitate those areas affected by the construction activities.
2. Where new rectangular openings are to be installed in concrete or concrete masonry walls or floors, the Contractor shall score the edges of each opening (both sides of wall or floor slab) by saw cutting clean straight lines to a minimum depth of 1 inch and then chipping out the concrete. Alternately, the sides of the opening (not the corners) can be formed by saw cutting completely through the slab or wall. Saw cuts deeper than 1 inch (or the depth of cover over existing reinforcing steel, whichever is less) shall not be allowed to extend beyond the limits of the opening. Corners shall be made square and true by a combination of core drilling and chipping or grinding. All necessary precautions shall be taken during removal of concrete to prevent debris from falling into or entering adjacent tanks in service or from damaging adjacent equipment or piping. Saw cuts allowed to extend beyond the opening shall be repaired by filling with non-shrink grout. The concrete around any exposed reinforcement steel shall be chipped back and exposed reinforcement steel cut a minimum of 2 inches from the finished face of the new opening and painted with epoxy paint. The inside face of the new opening shall be grouted with an epoxy cement grout to fill any voids and cover the exposed aggregate and shall be trowel-finished to provide a plumb and square opening.
3. Where existing rectangular openings are to be filled in concrete walls, the openings shall be filled with non-shrink grout and finished to match the adjacent area. The openings shall have a slight (45 degree) flare to facilitate grouting and the escape of entrained air during grouting. Before placing the non-shrink grout, concrete surfaces shall be sandblasted, thoroughly cleaned of sand and any other foreign matter, and coated with epoxy bonding compound.
4. When new piping is installed in existing structures, the Contractor shall accurately position core-drilled openings in the concrete as shown or otherwise required. Openings shall be of sufficient size to permit a final alignment of pipelines and fittings without defection of any part and to allow adequate space for satisfactory packing where pipe passes through the wall to ensure watertightness around openings so formed. The cores shall be provided with continuous keyways to hold the filling material in place, and they shall have a slight flare to facilitate grouting and the escape of entrained air during grouting. Before placing the non-shrink grout, concrete surfaces shall be sandblasted, thoroughly cleaned of sand and any other foreign matter, and coated with epoxy bonding compound.
 - a. The pipes, castings, or conduits, as specified, shall be grouted in place by pouring in grout under a head of at least 4 inches. The grout shall be poured or rammed or vibrated into place to fill completely the space between the pipes, castings, or conduits and the sides of the openings so as to obtain the same watertightness as through the wall itself. The grouting casings shall then be water cured.

- b. In all locations where the surface of the grout will be exposed to view, the non-shrink grout shall be recessed to 1/2-inch back of the exposed surface and the recessed area filled with cement mortar grout.
- 5. When new piping is to be connected to existing piping, the existing piping shall be cut square and ends properly prepared for the connection shown. Any damage to the lining and coating of the existing piping shall be repaired by the Contractor. Dielectric insulating joints shall be installed at interconnections between new and existing piping.
- 6. Where existing equipment, equipment pads and bases, piping, piping supports, electrical panels and devices, conduits, and associated appurtenances are removed, the Contractor shall rehabilitate the affected area such that little or no evidence of the previous installation remains. Openings in concrete floors, walls, and ceilings from piping, conduit, and fastener penetrations shall be filled with non-shrink grout and finished to match the adjacent area. Concrete pads and bases for equipment and supports shall be removed by chipping away concrete and cutting any exposed reinforced steel and anchor bolts a minimum of 2 inches below finished grade and shall be coated with Sikadur 31 Hi-Mod Gel or equal in accordance with Section 09960 – Protective Coatings. The area of concrete to be rehabilitated shall be scored by saw cutting clean, straight lines to a minimum depth of 1-1/2-inches (or the depth of cover over reinforcing steel, whichever is less). The area within the scored lines shall be patched with non-shrink grout to match the adjacent grade and finish. Abandoned connections to piping and conduits shall be terminated with blind flanges, caps, and plugs suited for the material, type, and service of the pipe or conduit. Existing pipes plugged with grout shall have grout penetrate to 2 feet into the pipe.
- 7. Existing reinforcement to remain in place shall be protected, cleaned, and extended into new concrete.
 - a. Where new concrete joins existing concrete at the removal line, reinforcement shall be cut-off flush with the concrete surface at the removal line.
 - b. Where the concrete surface at the removal line is the finished surface, the reinforcement shall be cut back 2 inches below the finished concrete surface, the ends painted with epoxy paint and the remaining holes patched with a cement mortar grout.
- 8. Where existing handrailing is removed, post embedments and anchors shall be cut flush at the concrete surface, post holes shall be filled with non-shrink grout flush to the floor surface and exposed embedments and anchors shall be coated with Sikadur 31 Hi-Mod Gel or equal in accordance with Section 09960 – Protective Coating. At the point of continuation of existing handrailing, a new post with rail connections matching the existing handrailing system shall be installed. New posts in existing concrete floors shall be installed in core-drilled socket holes and the annular space between the post and hole filled with non-shrink grout.
- 9. Where reconstruction activities damage the painting and coating of adjacent or nearby facilities, the damaged areas shall be surface prepared and coated

to match the original painting and coating with a compatible system in accordance with Section 09960 – Protective Coatings. Equipment items that are relocated shall be completely surface prepared and coated in accordance with Section 09960 – Protective Coating.

10. The Drawings identify the major equipment and structures to be demolished. Auxiliary systems such as water, auxiliary equipment, drainage, electrical wiring, controls, and instrumentation are not necessarily shown. In association with the electrical equipment demolition, the following work shall also be performed at no additional cost to the Owner.
 - a. All auxiliary utility support systems to facilitate proper operation of the plant shall remain in service except when auxiliary systems are identified for demolition in which case the systems may be decommissioned in accordance with sequencing and constraints in Section 01040. Auxiliary utility support systems include but are not limited to water, ventilation, lighting, and sump pumping. Temporary provisions may be made to maintain such systems during switchover.
 - b. During construction, electrical systems shall be maintained as required to support auxiliary utility support systems. These systems can and will be a combination of existing, temporary, and new items. All demolition work shall be performed in a manner and sequence to ensure continued operation of these auxiliary systems.
 - c. The area shall be thoroughly cleaned such that little or no evidence of the previous equipment installation will remain.
11. Where existing materials and equipment are removed or relocated, remove all materials no longer used such as studs, straps, conduits, and wires. Remove or cut off concealed or embedded conduit, boxes, or other materials and equipment to a point at least 2 inch below the final finished surface.

E. Disposal

1. Demolition and removal of debris shall be conducted to ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities which shall not be closed or obstructed without permission from the Owner. Alternate routes shall be provided around closed or obstructed traffic ways.
2. Site debris, rubbish, and other materials resulting from reconstruction operations shall be legally removed and disposed of at the Contractor's expense. Structures and equipment to be demolished shall be cleaned prior to demolition and the wash water properly disposed of. No trace of these structures shall remain prior to placing of backfill in the areas from which structures were removed.
3. The use of burning at the project site for the disposal of refuse, debris, and waste materials resulting from demolition and site clearing operations will not be permitted.

F. Occupancy and Pollution Control

1. Water sprinkling, temporary enclosures, chutes, and other suitable methods shall be used to limit dust and dirt rising and scattering in the area. Comply with all government regulations and Contract Documents requirements pertaining to environmental protection.
2. Water shall not be used when it creates hazardous or objectionable conditions such as ice, flooding, or pollution.

G. Cleaning

1. During and upon completion of work, the Contractor shall promptly remove unused tools and equipment, surplus materials, rubbish, debris, and dust and shall leave areas affected by work in a clean, approved condition.
2. Adjacent structures shall be cleaned of dust, dirt, and debris caused by reconstruction, as directed by the Engineer or governing authorities, and adjacent areas returned to condition existing prior to start of work.
3. The Contractor shall clean and sweep the street and road in accordance with Division 1.

END OF SECTION

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SECTION 02620 – HYDRAULIC STRUCTURE TESTING

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall perform all cleaning, flushing, and testing of all new or modified hydraulic structures and appurtenant piping, including conveyance of test water from Owner-designated source to point of use, and including all disposal thereof, complete, and acceptable, all in accordance with the requirements of the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Codes: All work specified herein shall conform to the requirements of all applicable codes and regulations.

1.3 CONTRACTOR SUBMITTALS

- A. A testing schedule, including proposed plans for water conveyance, control, disposal, and disinfection shall be submitted in writing for approval in accordance with the provisions of Section 01330 – Submittal Procedures. Also, the Contractor shall submit written notice a minimum of 72 hours before testing is to start.

PART 2 PRODUCTS

2.1 MATERIALS REQUIREMENTS

- A. Temporary valves, bulkheads, or other water control equipment and materials shall be as determined by the Contractor subject to the Engineer's review. No materials shall be used which would be injurious to the construction or its future function.

PART 3 EXECUTION

3.1 GENERAL

- A. Water for testing will be furnished by the Contractor as specified in Section 01500 – Construction Facilities and Temporary Controls; however, the Contractor shall make all necessary provisions for conveying the water from the source to the points of use.
- B. The Contractor shall be responsible for performing all work required by regulatory agencies, including, but not limited to, testing of the hydrostatic test water, and obtaining all required permits for discharge of test water. The Contractor is notified that use of potable water for hydrostatic tests does not necessarily guarantee approval by regulatory agencies for discharge of hydrostatic test water into sanitary sewers or storm drains.
- C. All testing operations shall be performed in the presence of the Engineer.

- D. If industrial paint finishes or other protective coatings are to be applied to the interior surfaces of the hydraulic structure, such coatings shall be applied after all testing operations have been completed.
- E. Release of water from structures, after testing has been completed, shall be in accordance with the testing plan submitted to and accepted by the Engineer and shall comply with all applicable laws and regulations.

3.2 PRELIMINARY CLEANING AND FLUSHING

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

3.3 TESTING OF HYDRAULIC STRUCTURES

- A. General: Testing shall be performed prior to backfilling, except where otherwise acceptable to the Engineer. Testing shall not be performed sooner than 14 days after all portions of structure walls and associated roof systems have been completed. The test shall consist of filling the structure with water to the maximum operating water surface. The rate of filling shall not exceed 24 inches of depth per day. There shall be no damp spots or visible seepage/leakage on exterior walls of the hydraulic structure. A damp spot shall be defined as a spot having sufficient moisture to be transferred to a dry hand upon touching. All visible leakage shall be repaired.
- B. Leakage Test and Repairs: After the structure has been filled, the water loss leakage test shall be performed as follows: an initial water level reading shall be made. Seven days following the initial reading, a second reading shall be made. The structure shall be considered to have passed the test if water loss during the 7-day period, as computed from the two water level readings, does not exceed 0.2 percent of the total volume of water in the structure, after allowance is made for evaporation loss. If intermediate readings or observed leakage indicate that the allowable leakage will be exceeded, the test may be terminated before the end of the 7-day period and appropriate action taken to correct the problem before commencing a new 7-day test period. Should the structure fail to pass the test, the test shall be repeated for up to 3 additional 7-day test periods. If, at the end of 28 days, the structure still fails to pass the leakage test, the Contractor shall empty the structure as acceptable to the Engineer and shall examine the interior for evidence of any cracking or other conditions that might be responsible for the leakage. Any cracks shall be "vee'd" and sealed with polyurethane sealant in accordance with Section 03300 – Cast-In-Place Concrete. Any evidence of leakage shall be repaired. Following these operations, the Contractor shall again test the hydraulic structure. The structure will not be accepted as completed until the water loss leakage test is passed and all visible leakage repaired.

3.4 TESTING OF APPURTENANT PIPING

- A. Piping appurtenant to hydraulic structures shall be tested as specified in Section 02640 – Pipeline Testing and Disinfection.

END OF SECTION

SECTION 02640 – PIPELINE TESTING AND DISINFECTION

PART 1 GENERAL

- 1.1 The contractor shall perform all cleaning, flushing, and testing, of all pipelines, and disinfection of all pipelines for potable water, including conveyance of test water from owner-designated source to point of use, and including all disposal thereof, complete, and acceptable, all in accordance with the requirements of the contract documents.
- 1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS
 - A. Codes: All work specified herein shall conform to the requirements of all applicable codes and regulations.
- 1.3 CONTRACTOR SUBMITTALS
 - A. A testing schedule, including proposed plans for water conveyance, control, disposal, and disinfection shall be submitted in writing for approval in accordance with the provisions of Section 01330 – Submittal Procedures. Also, the CONTRACTOR shall submit written notice a minimum of 72 hours before testing is to start.

PART 2 PRODUCTS

- 2.1 MATERIALS REQUIREMENTS
 - A. Temporary valves, bulkheads, or other water control equipment and materials shall be as determined by the CONTRACTOR subject to the ENGINEER's review. No materials shall be used which would be injurious to the construction or its future function.
 - B. Chlorine for disinfection shall be in the form of liquid chlorine, sodium hypochlorite solution, or calcium hypochlorite granules or tablets. Liquid chlorine shall be in accordance with the requirements of ANSI/AWWA B301; sodium hypochlorite and calcium hypochlorite shall be in accordance with the requirements of ANSI/AWWA B300. Liquid chlorine shall be used only (1) in combination with appropriate gas flow chlorinators and ejectors; (2) under the direct supervision of an experienced technician; and (3) when appropriate safety practices are observed.
 - C. Test gages shall be laboratory-calibrated test gages and shall be recalibrated by a certified laboratory at the CONTRACTOR's expense prior to the leakage test, if required by the ENGINEER.

PART 3 EXECUTION

- 3.1 GENERAL
 - A. Water for testing will be furnished by the CONTRACTOR as specified in Section 01500 – Construction Facilities and Temporary Controls. The CONTRACTOR shall

make all necessary provisions for conveying the water from the source to the points of use.

- B. The CONTRACTOR shall be responsible for performing all work required by regulatory agencies, including, but not limited to, testing of the hydrostatic test water, and obtaining all required permits for discharge of test water. The CONTRACTOR is notified that use of potable water for hydrostatic tests does not necessarily guarantee approval by regulatory agencies for discharge of hydrostatic test water into sanitary sewers or storm drains.
- C. All testing operations shall be performed in the presence of the ENGINEER.
- D. Conduct the tests on piping after the piping has been completely installed, including all backfill, supports, hangers, and anchors.
- E. Pipelines conveying the following fluids shall be disinfected following hydraulic testing. All disinfection shall be done in the presence of the ENGINEER.
 - 1. 1W (potable water)
 - 2. 3W (utility water)
- F. Disinfection operations shall be scheduled by the CONTRACTOR as late as possible during the Contract time period so as to assure the maximum degree of sterility of the facilities at the time the Work is accepted by the OWNER. Bacteriological testing shall be performed by a certified testing laboratory acceptable to the Owner. Results of the bacteriological testing shall be satisfactory to the State Department of Health or other appropriate regulatory agency.
- G. Release of water from pipeline, after testing and disinfecting (as applicable) have been completed, shall be in accordance with the testing plan submitted to and accepted by the ENGINEER and shall comply with all applicable laws and regulations.

3.2 PRELIMINARY CLEANING AND FLUSHING

- A. Prior to hydrostatic testing, all new pipelines shall be flushed or blown out as appropriate.

3.3 TESTING OF NON-PRESSURE PIPELINES

- A. General: Unless otherwise specified, all process drains, storm drain lines and other miscellaneous drain piping shall be tested for exfiltration or infiltration, according to State and Local standards and as specified herein. Where the two specifications are in conflict, the more stringent of the two shall be followed. All manhole(s)/inlet(s) shall be tested for leakage, as specified. Manhole(s)/inlet(s) shall be tested prior to backfill placement, whereas all pipes shall be backfilled prior to testing. All leakage tests shall be completed and approved prior to placing permanent surfacing. When leakage or infiltration exceeds the amount allowed by the Specifications, the CONTRACTOR, at its expense, shall locate the leaks and make the necessary repairs or replacements in accordance with the Specifications to reduce the leakage or infiltration to the specified limits. Any individually detectable leaks shall be repaired, regardless of the results of the tests.

- B. Leakage Tests: Unless otherwise specified or shown, storm drainage and miscellaneous drainage systems shall be tested for leakage as follows:
1. For Pipe 24 inches or less in diameter, where difference in elevation between inverts of adjacent manhole(s)/inlet(s) is 10 feet or less; water exfiltration test or water infiltration test as approved. The ENGINEER may allow substitution of an air pressure test for the water exfiltration test.
 2. For Pipe 24 inches or less in diameter, where difference in elevation between inverts of adjacent manhole(s)/inlet(s) is greater than 10 feet; air pressure test or water infiltration test, or as approved.
 3. For Pipe greater than 24 inches in diameter; air pressure test or water infiltration test, or as approved.
- C. Water Exfiltration Test: Each section of pipe shall be tested between successive manhole(s)/inlet(s) by closing the lower end of the pipeline to be tested and the inlet pipe of the upper manhole/inlet with stoppers. The pipe and manhole/inlet shall be filled with water to a point 4 feet above the centerline of the sewer (except as limited by finish grade at manhole/inlet) depth at the center of the upper manhole/inlet; or if groundwater is present, 4 feet above the average adjacent groundwater level, whichever is higher.

The allowable leakage shall be computed by the formula:

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

Where:

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

L = Length of pipeline tested, including laterals, in feet.

D = Internal diameter of the pipe in inches.

H = Difference in elevation between the water surface in the upper manhole/inlet and the centerline of the pipe at the lower manhole/inlet; or if groundwater is present above the centerline of the pipe in the lower manhole/inlet, the difference in elevation between the water surface in the upper manhole/inlet and the groundwater at the lower manhole/inlet.

- D. Water infiltration test: if, in the opinion of the engineer, excessive groundwater is encountered in the construction of a section of the pipeline, the exfiltration test for leakage shall not be used. The end of the pipeline at the upper structure shall be closed sufficiently to prevent the entrance of water, and pumping of groundwater shall be discontinued for at least 3 days, after which the section shall be tested for infiltration. The infiltration into each individual reach of pipeline between adjoining manhole(s)/ inlet(s) shall not exceed that allowed by the formula in subsection 3.3c, where h is the difference in the elevation between the groundwater surface and the invert of the sewer at the downstream manhole/inlet. Unless otherwise specified, infiltration will be measured by the contractor using measuring devices approved by the engineer.

- E. Air pressure test: the contractor shall furnish all materials, equipment, and labor for making an air test. Air test equipment shall be approved by the engineer. The contractor may conduct an initial air test of the pipeline after densification of the backfill but, in the case of sanitary sewer testing, prior to installation of the building drains. Such tests will be considered to be for the contractor's convenience and need not be performed in the presence of the engineer. Each section of pipeline shall be tested between successive manhole(s)/inlet(s) by plugging and bracing all openings in the main pipeline and the upper ends of all outlets and building drains. Prior to any air pressure testing, all pipe plugs shall be checked with a soap solution to detect any air leakage. If any leaks are found, the air pressure shall be released, the leaks eliminated, and the test procedure started over again.
- F. The final leakage test of the pipeline and outlet branches shall be conducted in the presence of the engineer and shall be performed in accordance with the procedures defined in ansI/astm c828.
- G. At the contractor's option, joints may be air tested individually, joint by joint, with the use of specialized equipment. The contractor shall submit its joint testing procedure for the engineer's review and demonstrate, to the engineer's satisfaction, that the testing procedure will adequately evaluate the pipe system being tested, prior to actual testing. Prior to each test, the pipe at the joint shall be wetted with water. The maximum test pressure shall be 3.0 psi. The minimum allowable pressure drop shall be 1.0 psi over a 30-second test period.
- H. Water pressure test: preparatory to testing, the section of the pipeline to be tested shall be filled with water and placed under a slight pressure for at least 48 hours. The pipeline shall then be brought up to the test pressure specified and maintained on the section under test for a period of not less than 4 hours.
- I. Accurate means shall be provided for measuring the quantity of water required to maintain full pressure on the line for the test period, which volume shall not exceed:

$$L = \frac{CN D (P)^{1/2}}{1850}$$

Where:

L = Maximum allowable leakage in gallons per hour for the section of pipeline tested

N = Number of joints in length tested

D = Diameter of pipe in inches

P = Test pressure in psi

C = 1.0 for non-pressure polyethylene or PVC pipe

C = 3.0 for reinforced concrete pressure pipe with rubber joints, non-cylinder type

- J. Deflection test: all flexible and semi-rigid main line pipe shall be tested for deflection, joint displacement, or other obstruction by passing a rigid mandrel through the pipe by hand, not less than 30 days after completion of the trench backfill, but prior to permanent resurfacing. The mandrel shall be a full circle, solid cylinder, or a rigid, non-adjustable, odd-numbered leg (9 leg minimum) steel cylinder, approved by the engineer as to design and manufacture. The circular cross section of the mandrel shall have a diameter of at least 95 percent of the specified average inside pipe diameter of the pipe and the minimum length of the circular portion of the mandrel shall be equal to the nominal diameter of the pipe. Obstructions encountered by the mandrel shall be corrected by the contractor.

3.4 TESTING OF MANHOLES AND INLETS

- A. All manhole(s)/inlet(s) shall be hydrostatically tested for leakage after installation, but prior to being backfilled. Prior to hydrostatic testing, all manhole(s)/inlet(s) shall be visually inspected for leaks. All leaks or cracks shall be repaired by the contractor, prior to hydrostatic testing, to the satisfaction of the engineer.
- B. All pipes entering the manhole/inlet shall be sealed at a point outside the manhole/inlet walls so as to include testing of the pipe/manhole joints.
- C. The manhole/inlet shall be filled with water to a level 2 inches below the top of the frame. Safety lines shall be secured to all plugs utilized. After a period of at least one hour to allow the water level to stabilize, the manhole/inlet shall be refilled and the water level shall be checked. The water level shall again be checked after a period of 4 hours. If the water level is reduced by more than 1/4-inch, the leakage shall be considered excessive, and the contractor shall be required to make all necessary repairs and retest the manhole/inlet. The exterior of the manhole/inlet shall be inspected during this period for visible evidence of leakage. Visible moisture, sweating, or beads of water on the exterior of the manhole/inlet shall not be considered leakage, but any water running across the surface will be considered leakage and shall be repaired to the satisfaction of the engineer regardless of the volume of water lost.

3.5 TESTING OF PRESSURE PIPELINES

- A. No section of the pipeline shall be tested until all field-placed concrete or mortar has attained an age of 14 days. The test shall be made by closing new valves when available, or by placing temporary bulkheads in the pipe and filling the line slowly with water. Testing shall not be performed against existing system closed valves. The contractor shall be responsible for ascertaining that all test bulkheads are suitably restrained to resist the thrust of the test pressure without damage to, or movement of, the adjacent pipe. Any unharnessed sleeve-type couplings, expansion joints, or other sliding joints shall be restrained or suitably anchored prior to the test, to avoid movement and damage to piping and equipment. Care shall be taken to see that all air vents are open during filling.
- B. Where any section of pipe is provided with concrete thrust blocking, do not make the pressure test until at least 14 days have elapsed after the thrust blocking is installed. If high early strength cement is used for thrust blocking, the time may be

reduced to 3 days. When testing PVC or hdpe piping, slowly fill the section of pipe to be tested with water and allow to stand for 24 hours under slight pressure to allow the PVC or hdpe pipe to accommodate swelling/absorption. Refill with makeup water before test.

- C. Hydrostatic testing. Expel all air from the piping system prior to testing and apply and maintain the test pressure hereinafter specified by means of a hydraulic force pump. Valve off the piping system when the test pressure is reached and conduct the pressure test for the specified time, reopening the isolation valve only as necessary to restore the test pressure. The pump suction shall be in a barrel or similar device, or metered so that the amount of water required to maintain the test pressure may be measured accurately. Pressure tests shall be made by filling the system for two hours continuously.
- D. The pipeline shall be filled at a rate that shall not cause any surges or exceed the rate at which the air can be released through the air valves at a reasonable velocity and all the air within the pipeline shall be properly purged. After the pipeline or section thereof has been filled, it shall be allowed to stand under a slight pressure for at least 24 hours to allow the concrete or mortar lining, as applicable, to absorb what water it will, to allow the pipe and water to achieve temperature equilibrium and to allow the escape of air from any air pockets. During this period, bulkheads, valves, and connections shall be examined for leaks. If leaks are found, corrective measures satisfactory to the engineer shall be taken.
 - 1. Repairs of defects that are discovered as a result of inspection or tests shall be made with new materials. Caulking of screwed joints, cracks, or holes will not be accepted. Tests shall be repeated after defects have been eliminated at no additional cost to the owner.
- E. The pipeline being tested will be equipped with a relief valve to permit pressure relief if the pressure exceeds 20 to 25 percent above the required test pressure to prevent pipeline failure.
- F. Pressure gauge(s): provide sufficient number of calibrated pressure gauges capable of measuring pressure 50 percent over intended test pressure. Location of pressure gauges shall be determined by the contractor and submitted with the pressure test plan, subject to approval by the engineer.
- G. Pressure gauges and relief valves shall be checked for accuracy to the satisfaction of the engineer before being used during actual testing of pipeline.
- H. The hydrostatic test shall consist of holding the test pressure on the pipeline for a period of 4 hours. The test pressure for yard piping shall be as shown or specified on the piping schedule measured at the lowest point of the pipeline section being tested. All visible leaks shall be repaired in a manner acceptable to the engineer.
- I. Allowable Leakage:
 - 1. If not specified in the piping schedule or in these specifications, the maximum allowable leakage for pressure pipelines shall be 10 u.s. gallons per inch of diameter per mile of pipe per 24 hours for pipe with 40-ft or greater lengths between joints and with rubber-gasketed joints and 20 u.s. gallons per inch of

diameter per mile of pipe per 24 hours for pipe with 20-ft or less lengths between joints and with rubber-gasketed joints.

2. Pipe with welded joints shall have no leakage.
3. Exposed pipe: leakage shall be zero at the test pressure hereinafter specified throughout the duration for exposed piping. Conduct testing and maintain the testing pressure for two hours continuously.
4. In the case of pipelines that fail to pass the prescribed leakage test, the contractor shall determine the cause of the leakage, shall take corrective measures necessary to repair the leaks, and shall again test the pipelines.
5. The pipes shall be drained after hydrostatic testing, unless otherwise permitted by the engineer.
6. Pneumatic testing
 - a. General: pneumatic testing shall be performed on pipes as indicated on the piping schedule. Air used for testing shall be dry and oil-free. The piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of leakage.
 - b. Procedure: 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 connection, examine for leakage. Correct visible leaks and repeat preliminary test until visible leaks are corrected. Gradually increase pressure in system to half of the test pressure. Test pressures are specified in the pipe schedule. Thereafter, increase pressure in steps of approximately one-tenth of specified test pressure until required test pressure is reached. Maintain pneumatic test pressure for minimum of 10 minutes and for such additional time as necessary to conduct soap bubble examination for leakage. Correct visible leakage and retest as specified.

3.6 TEST RECORDS

- A. The contractors shall submit a sample test record form for review by the construction manager in accordance with section 01300. The contractor shall record and maintain all tests performed and shall submit test records to the construction manager within 24-hour of test completion. Test records shall include as a minimum:
 1. Date and time of beginning and end of pipeline testing.
 2. Identification of pipeline being tested.
 3. Test fluid.
 4. Test pressure.
 5. Ambient temperature.
 6. Pressure gauge reading taken during the test.

7. Quantities of make-up water added during the test.
8. Signatures of test technician, contractor's representative who witnessed the test, and the owner representative who witnessed the test.

3.7 DISINFECTION OF PIPELINES

- A. General: the contractor shall disinfect all potable water pipelines in accordance with the requirements of ansi/awwa c651 using the continuous-feed method as modified herein.
- B. Chlorination: a chlorine-water mixture shall be uniformly introduced into the pipeline by means of a solution-feed chlorinating device. The chlorine solution shall be introduced at one end of the pipeline through a tap in such a manner that as the pipeline is filled with water, the dosage applied to the water entering the pipe shall be approximately 50 mg/l. A backflow prevention device shall be installed on the water supply line to prevent the strong chlorine solution in the line being disinfected from flowing back into the line supplying the water.
- C. Retention period: chlorinated water shall be retained in the pipeline long enough to destroy all non-spore-forming bacteria. This period shall be at least 24 hours. After the chlorine-treated water has been retained for the required time, the free chlorine residual at the pipeline extremities and at other representative points shall be at least 25 mg/l.
- D. Chlorinating valves: during the process of chlorinating the pipelines, all valves and other appurtenances shall be operated while the pipeline is filled with the heavily chlorinated water.
- E. Final flushing: after the applicable retention period, the heavily chlorinated water shall be flushed from the pipeline until chlorine measurements show that the concentration in the water leaving the pipeline is no higher than that generally prevailing in the system or is acceptable for domestic use. If there is any question that the chlorinated discharge will cause damage to the environment, a reducing agent shall be applied to the water to neutralize thoroughly the chlorine residual remaining in the water.
- F. Bacteriological testing: after final flushing and before the pipeline is placed in service, a sample, or samples shall be collected by the contractor from the end of the line and shall be tested for bacteriological quality in accordance with the requirements of the state department of health or other appropriate regulatory agency. For this purpose, the pipe shall be re-filled with fresh potable water and left for a period of 24 hours before any sample is collected. Should the initial disinfection treatment fail to produce satisfactory bacteriological test results, the disinfection procedure shall be repeated until acceptable results are obtained.

3.8 CONNECTIONS TO EXISTING SYSTEM

- A. Where connections are to be made to an existing potable water system, the interior surfaces of all pipe and fittings used in making the connections shall be swabbed or sprayed with a one percent hypochlorite solution before they are installed. Thorough flushing shall be started as soon as the connection is completed and shall be continued until discolored water is eliminated.

3.9 FACTORY TESTING

- A. Except where otherwise specified, all materials used in the manufacture of the pipe shall be tested in accordance with the applicable specifications and standards. Welds shall be tested as specified. The contractor shall perform all tests at no additional cost to the owner.

END OF SECTION

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SECTION 03100– CONCRETE FORMWORK

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Furnish all labor, materials, equipment and incidentals required and design, install and remove formwork for cast-in-place concrete as shown on the Drawings and as specified herein.
- B. Secure to forms as required or set for embedment as required, all miscellaneous metal items, sleeves, reglets, anchor bolts, inserts and other items furnished under other Sections and required to be cast into concrete.
- C. Forms for architectural concrete.

1.2 RELATED WORK

- A. Related Work Specified Elsewhere:
 - 1. Section 03200, Concrete Reinforcement
 - 2. Section 03150, Concrete Joints and Joint Accessories
 - 3. Section 03300, Cast-in-Place Concrete
 - 4. Section 03600, Grout

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. American Concrete Institute (ACI)
 - 1. ACI 117 – Standard Specifications for Tolerances for Concrete Construction and Materials
 - 2. ACI 301 - Specifications for Structural Concrete
 - 3. ACI 318 - Building Code Requirements for Structural Concrete
 - 4. ACI 347 – Guide to Formwork for Concrete
- B. American Plywood Association (APA)
 - 1. APA - Material Grades and Designations as Specified
- C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.4 SUBMITTALS

- A. Submit to the ENGINEER, in accordance with Division 1, shop drawings and product data showing materials of construction and details of installation for:
 - 1. Form release agent

2. Form ties
3. Form liners
4. Bond breakers
5. Void Forms
6. Architectural concrete forming system

- B. Falsework and Drawings: The CONTRACTOR's attention is directed to the provisions of Section 1717 of the Division of Industrial Safety, Construction Safety Orders, which requires that all falsework or vertical shoring installations where the height of the falsework or vertical shoring, as measured from the top of the sills to the soffit of the superstructure, exceeds 14-feet, or where individual horizontal span lengths exceed 16- feet, or provision for vehicular or railroad traffic through falsework or vertical shoring is made, shall be approved and signed by a Professional Civil Engineer, registered in the State of California; provided further, that a copy of the falsework plan or shoring layout shall be available on the job site at all times.
- C. The CONTRACTOR shall, in accordance with the requirements in Division 1, submit detailed plans of falsework proposed to be used. Such plans shall be in sufficient detail to indicate the general layout, sizes of members, anticipated stresses, grade of materials to be used in the falsework, and typical soil conditions.
- D. Location and sequence of the concrete placement. Indicate locations of form joints, form-tie layout, panel sizes and patterns.
- E. Review of pour sequence, form system and panel layout shall be for appearance and conformance to design concept only. ENGINEER's review of the forming plans or procedures shall not relieve the CONTRACTOR of responsibility for the strength, safety or correctness of methods used, the adequacy of equipment, or from carrying out the work in full compliance with the requirements of the Drawings and as specified herein.

1.5 QUALITY ASSURANCE

- A. The form liner manufacturer's representative shall be on-site during initial installation of the form liner to instruct the CONTRACTOR on the proper methods of application and use of the liner. S/He shall be available to answer any questions on the liner that the ENGINEER may have.

1.6 SYSTEM DESCRIPTION

- A. General: Architectural Concrete is wall, slab, beam or column concrete which will have surfaces exposed to view in the finished work. It includes similar exposed surfaces in water containment structures from the top of the walls to 2-ft below the normal water surface in open tanks and basins.
- B. Structural Design Responsibility – All forms and shoring shall be designed at the CONTRACTOR's expense by a Professional Civil Engineer, registered in the State of California. Formwork shall be designed and erected in accordance with the requirements of ACI 301 and ACI 318 and as recommended in ACI 347 and shall comply with all applicable regulations and codes. The design shall consider any special requirements due to the use of plasticized and/or retarded set concrete.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configurations desired.

2.2 MATERIALS

- A. Forms for cast-in-place concrete shall be made of wood, metal, or other approved material. Wood forms for the project shall be new and unused. Construct wood forms of sound lumber or plywood of suitable dimensions and free from knotholes and loose knots. Where used for exposed surfaces, dress and match boards. Sand plywood smooth and fit adjacent panels with tight joints. Metal forms may be used when approved by the ENGINEER and shall be of an appropriate type for the class of work involved. All forms shall be designed and constructed to provide a flat, uniform concrete surface requiring minimal finishing or repairs.
- B. Wall Forms:
 - 1. Forms for all exposed exterior and interior concrete walls shall be new and unused "Plyform" exterior grade plywood panels manufactured in compliance with APA and bearing the trademark of that group, or equal acceptable to the ENGINEER. Provide B grade or better veneer [with High Density Overlay (HDO)] on all faces to be placed against concrete during forming. The class of material and grades of interior plies shall be of sufficient strength and stiffness to provide a flat, uniform concrete surface requiring minimal finishing and grinding.
 - 2. All joints or gaps in forms shall be taped, gasketed, plugged, and/or caulked with an approved material so that the joint will remain watertight and will withstand placing pressures without bulging outward or creating surface patterns.
 - 3. Forms for circular structures shall conform to the circular shape of the structure. Straight panels may be substituted for circular panels if the straight panels do not exceed 2-ft in width nor deflect more than 3-1/2 degrees per joint, nor conflict with specific notes on the Drawings.
- C. Rustications shall be at the location and shall conform to the details shown on the Drawings. Moldings for chamfers and rustications shall be milled and planed smooth. Rustications and corner strips shall be of a nonabsorbent material, compatible with the form surface and fully sealed on all sides to prohibit the loss of paste or water between the two surfaces.
- D. Form Release Agent – Coat all forming surfaces in contact with concrete using an effective, non-staining, non-residual, water-based, bond-breaking form coating, unless otherwise noted.
- E. Forms for Architectural Concrete or Concrete Receiving Architectural Finish.
 - 1. Forms for architectural concrete shall be constructed of materials and in a manner that will result in rigid forms with sufficient strength to withstand, without noticeable deflection, movement, or leakage, the high hydraulic pressures resulting from rapid filling of the forms and heavy high frequency vibration of the concrete. Deflection in formwork shall be limited to 1/360 of each component span. Form joints shall be laid out in a uniform pattern or as indicated on the Drawings.

2. Form material for producing architectural finishes shall be constructed of either steel fiberglass reinforced plastic or high density overlay plywood.

F. Form Liners:

1. Architectural Formliners: Plastic Formliner, fluted Rib Pattern, 1 ½" deep, 6" on center, 2 ½" peak and valley. Dayton Superior 1 ½" Deep Rib Pattern F940012; Fitzgerald Formliners VinylLok Fluted Rib Pattern 14314, or equivalent.

G. Form Ties:

1. Form ties encased in concrete other than those specified in the following paragraphs shall be designed so that, after removal of the projecting part, no metal shall remain within 1½-inches of the face of the concrete. The part of the tie to be removed shall be at least ½-inch diameter or be provided with a wood or metal cone at least ½-inch diameter and 1½-inches long. Form ties in concrete exposed to view shall be the cone-washer type.
2. Form ties for exposed exterior and interior walls shall be as specified in the preceding paragraph except that the cones shall be approved wood or plastic.
3. Flat bar ties for panel forms shall have plastic or rubber inserts having a minimum depth of 1½-inches and sufficient dimensions to permit proper patching of the tie-hole.
4. Ties for liquid containment structures shall have a neoprene washer at the center of the tie. Snap-Ties shall be Meadow Burke, Tampa, FL , Gates & Sons, Inc., Denver, CO, or approved equal.
5. Common wire shall not be used for form ties.
6. Alternate form ties consisting of tapered through-bolts at least 1-inch in diameter at the smallest end or through-bolts that utilize a removable tapered sleeve of the same minimum size may be used at the CONTRACTOR's option. Obtain ENGINEER's acceptance of system and spacing of ties prior to ordering or purchasing of forming. Clean, fill and seal form tie hole with non-shrink cement grout. The CONTRACTOR shall be responsible for water-tightness of the form ties and any repairs needed.

H. Void Forms.

1. Void forms used directly below structural slabs shall be 8-in deep preformed cardboard having sufficient strength to support the weight of the reinforcement and the wet concrete placed directly above or adjacent to it without deflecting the void form more than ½-in. Manufacturers include Vertical Chicago Inc., Melrose Park, IL – Vertical Core Material ½-in 50-50-0; Falcon Manufacturing Co., Denver, CO – Sure Void Under Slab Void, or approved equal.

PART 3 EXECUTION

3.1 GENERAL

- A. Forms shall be used for all cast-in-place concrete including sides of footings. Forms shall be constructed and placed so that the resulting concrete will be of the shape, lines, dimensions, and appearance indicated on the Drawings.

- B. Forms for walls shall have removable panels at the bottom for cleaning, inspection and joint surface preparation. Forms for wall heights in excess of 16 feet shall have closable intermediate inspection ports. Tremies and hoppers for placing concrete shall be used to allow concrete inspection, prevent segregation, and prevent the accumulation of hardened concrete on the forms above the fresh concrete.
- C. Molding, bevels, or other types of chamfer strips shall be placed to produce blockouts, or chamfers as shown on the Drawings or as specified herein. Chamfer strips shall be provided at horizontal and vertical projecting corners to produce a 3/4-inch chamfer. Rectangular or trapezoidal moldings shall be placed in locations requiring sealants where specified or shown on the drawings. Size of moldings shall conform to the sealant manufacturer's recommendations.
- D. Forms shall be sufficiently rigid to withstand construction loads and vibration and to prevent displacement or sagging between supports. Construct forms such that the concrete and/or exposed rebar (dowels) will not be damaged by their removal. The CONTRACTOR shall be entirely responsible for the adequacy of the forming system.
- E. Before form material is re-used, all surfaces to be in contact with concrete shall be thoroughly cleaned, all damaged places repaired, all projecting nails withdrawn and all protrusions smoothed. Reuse of wooden forms for other than rough finish will be permitted only if a "like-new" condition of the form is maintained.
- F. Metal items, such as rebar, wire, or plates used to support pipe penetrations and pipe embedment shall have a minimum clearance of 2-inches from reinforcing bars.
- G. Tolerances in concrete construction shall be in accordance with ACI 117, unless otherwise noted.

3.2 FORM TOLERANCE

- A. Forms shall be surfaced, designed, and constructed in accordance with the recommendations of ACI 347 and shall meet the following additional requirements for specified finishes.
- B. Formed Surfaces Exposed to View – Edges of all form panels in contact with concrete shall be flush within 1/32-inch and forms for plane surfaces shall be such that the concrete will be plane within 1/16-inch in 4-feet. Forms shall be tight to prevent the passage of mortar, water, and grout. The maximum deviation of the finish wall surface at any point shall not exceed 1/4-inch from the intended surface as shown on the Drawings. Form panels shall be arranged symmetrically and in an orderly manner to minimize the number of seams.
- C. Formed surfaces not exposed to view or buried shall meet the requirements of Class "C" Surface in ACI 347.
- D. Formed rough surfaces including mass concrete, pipe encasement, electrical duct encasement and other similar installations shall have no minimum requirements for surface smoothness and surface deflections. The overall dimensions of the concrete shall be plus or minus 1-inch.
- E. Architectural Concrete: All smooth faces to be exposed to view shall have surface deflections limited to 1/32-in at any point and the variation in wall deflection shall not exceed 1/16-in per 4-ft. The maximum deviation of the finished wall surface at any point shall not exceed 1/4-in from the intended surface as shown on the Drawings. All

textured faces, form lines, or rustications to be exposed to view shall be straight, plumb and true with a variation of no more than 1/4-in in 10-ft measured in any direction.

3.3 FORM PREPARATION

- A. Wood forms in contact with concrete shall be coated with an effective release agent prior to form installation.
- B. Steel forms shall be thoroughly cleaned and mill scale and other ferrous deposits shall be sandblasted or otherwise removed from the contact surface for all forms except those utilized for surfaces receiving a rough finish. All forms shall have the contact surfaces coated with a release agent.
- C. Form liners to be installed for architectural concrete finish shall be in accordance with the manufacturer's recommendations.

3.4 REMOVAL OF FORMS

- A. The CONTRACTOR shall be responsible for all damage resulting from removal of forms. Form removal shall conform to the requirements specified in Section 03300.
- B. Failure of the forms to comply with the requirements specified herein, or to produce concrete complying with the requirements of this Section, shall be grounds for rejection of that portion of the form/concrete work. Rejected work shall be repaired or replaced as directed by the ENGINEER at no additional cost to the OWNER. Such repair or replacement shall be subject to the requirements of this Section and approval of the ENGINEER.

3.5 FALSEWORK

- A. The CONTRACTOR shall be responsible for the design, engineering, construction, maintenance, and safety of all falsework, including staging, walkways, forms, ladders, and similar appurtenances, which shall equal or exceed the applicable requirements of the provisions of the OSHA Safety and Health Standards for Construction, the requirements of the Construction Safety Orders of the California Division of Industrial Safety, and the requirements specified herein.
- B. All falsework shall be designed and constructed to provide the necessary rigidity and to support the loads. Falsework for the support of a superstructure shall be designed to support the loads that would be imposed if the entire superstructure were placed at one time.
- C. Falsework shall be placed upon a solid footing, safe against undermining, and protected from softening. When the falsework is supported on timber piles, the maximum calculated pile loading shall not exceed 20-tons. When falsework is supported on any portion of the structure, which is already constructed, the loading imposed by the falsework shall be spread, distributed, and braced in such a way as to avoid any possibility of damage to the structure.

END OF SECTION

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SECTION 03150 – CONCRETE JOINTS AND JOINT ACCESSORIES

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Furnish all labor, materials, equipment and incidentals required and install accessories for concrete joints as shown on the Drawings and as specified herein.

1.2 RELATED WORK

- A. Related Work Specified Elsewhere:
 - 1. Section 03100, Concrete Formwork
 - 2. Section 03200, Concrete Reinforcement
 - 3. Section 03300, Cast-in-Place Concrete
 - 4. Section 03600, Grout
 - 5. Section 05500, Miscellaneous Metals

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Federal Specifications
 - 1. SS-S-210A - Sealing Compound, Preformed Plastic, for Expansion Joints and Pipe Joints.
- B. ASTM International (ASTM)
 - 1. ASTM A675 - Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties.
 - 2. ASTM C881 - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
 - 3. ASTM C1059 - Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete.
 - 4. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction. (Nonextruding and Resilient Bituminous Types).
 - 5. ASTM D1752 - Standard Specification for Preformed Sponge Rubber and Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.
- C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.4 SUBMITTALS

- A. Submit to the ENGINEER, in accordance with Division 1, submittals including the following:
 - 1. Premolded Joint Fillers - product data including catalogue cut, technical data, storage requirements, installation requirements, location of use and conformity to ASTM standards.
 - 2. Bond Breaker - product data including catalogue cut, technical data, storage requirements, installation requirements, location of use and conformity to ASTM standards.
 - 3. Compressible Joint Filler - product data including catalogue cut, technical data, storage requirements, installation requirements, location of use and conformity to ASTM standards.
 - 4. Bonding Agents - product data including catalogue cut, technical data, storage requirements, product life, application requirements and conformity to ASTM standards.
- B. Certifications:
 - 1. Certification that all materials used within the joint system are compatible with each other.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.
- B. All materials used together in a given joint (bond breakers, backer rods, joint fillers, sealants, etc.) shall be compatible with one another. Coordinate selection of suppliers and products to ensure compatibility. Under no circumstances shall asphaltic bond breakers or joint fillers be used in joints receiving sealant.

2.2 MATERIALS

- A. Premolded Joint Filler:
 - 1. Premolded joint filler - Structures. Self-expanding cork, premolded joint filler shall conform to ASTM D1752, Type III. The thickness shall be 3/4-in unless shown otherwise on the Drawings.
- B. Bond Breaker:
 - 1. Bond breaker tape shall be an adhesive-backed glazed butyl or polyethylene tape that will satisfactorily adhere to the premolded joint filler or concrete surface as required. The tape shall be the same width as the joint.
 - 2. Except where tape is specifically called for on the Drawings, bond breaker for concrete shall be either bond breaker tape or a non-staining type bond

prevention coating such as Silcoseal Select, by Nox-Crete, Omaha, Nebraska; or equal.

C. Bonding Agent:

1. Epoxy bonding agent shall be two-component, solvent-free, moisture insensitive, epoxy resin material conforming to ASTM C881, Type II. The bonding agent shall be Sikadur 32 Hi-Mod by Sika Corporation; Concrecive Liquid LPL by BASF Building Systems; or equal.
2. Latex bonding agent shall be non-reemulsifiable acrylic-polymer latex conforming to ASTM C1059, Type II.

PART 3 EXECUTION

3.1 INSTALLATION

A. Construction Joints:

1. Make construction joints only at locations shown on the Drawings or as approved by the ENGINEER. Any additional or relocation of construction joints proposed by the CONTRACTOR, must be submitted to the ENGINEER for written approval.
2. All joints shall be perpendicular to main reinforcement. Continue reinforcing steel through the joint as indicated on the Drawings.
3. Provide sealant grooves for joint sealant where indicated on the Drawings.
4. At all construction joints and at concrete joints designated on the Drawings to be "roughened", uniformly roughen the surface of the concrete to a full amplitude (distance between high and low points or side to side) of approximately 1/4-inch to expose a fresh face. Thoroughly clean joint surfaces of loose or weakened materials by water blasting or sandblasting and prepare for bonding. At least 2 hours before and again shortly before the new concrete is deposited, the joints and adjacent concrete surfaces to at least 12-inches past the joint shall be saturated with water.
5. In lieu of the above method for bonding plastic concrete to hardened concrete, the following optional method may be used. Concrete must be allowed to set a minimum of 28 days. Use a latex-bonding agent applied to roughened and cleaned surfaces of set concrete in strict accordance with manufacturer's recommendations.
6. Keyways shall not be used in construction joints unless specifically shown on the Drawings or approved by the ENGINEER.

END OF SECTION

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SECTION 03200 - CONCRETE REINFORCEMENT

PART 1 GENERAL

1.1 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install all concrete reinforcement complete as shown on the Drawings and as specified herein.

1.2 RELATED SECTIONS

- A. Section 03100 - Concrete Forms and Accessories
- B. Section 03150 - Concrete Joints and Accessories
- C. Section 03300 - Cast-in-Place Concrete
- D. Section 03600 - Grouts

1.3 SUBMITTALS

- A. All submittals shall be in accordance with the Standard and Special Provisions.
- B. Reinforcing Steel - Submit to the Engineer, in accordance with the Standard Provisions, placement drawings conforming to the recommendations of ACI 315. All reinforcement in a concrete placement shall be included in a single placement drawing or cross-referenced to the pertinent main placement drawing. The main drawing shall include the additional reinforcement (around openings, at corners, etc.) shown on the standard details sheets. Bars to have special coatings and/or to be of special steel or special yield strength are to be clearly identified.
- C. Bar Bending Details - The bars shall be referenced to the same identification marks shown on the placement drawings. Bars to have special coatings and/or to be of special steel or special yield strength shall be clearly identified.
- D. Mechanical Connectors - Submit two samples of each type of mechanical reinforcing steel connectors.
- E. Test Reports - Submit test reports for each of the following items:
 - 1. Mill Test - Submit a certified copy of mill test on each steel proposed for use showing the physical properties of the steel and the chemical analysis.
 - 2. Foreign Manufactured Steel - Submit a certified copy of test reports for each foreign manufactured steel proposed for use in the fabrication of reinforcement. The tests shall be specifically made for this project at the expense of the Contractor by a domestic independent testing laboratory certified to perform the tests. The testing shall be for conformity to the applicable ASTM standard(s).
 - 3. Beam Cages - Submit a certified copy of weld test report(s) for beam cages fabricated by means of the Schnell IDEA Machine.

4. Welder - Welder certification shall be in accordance with AWS D1.4 when welding of reinforcement is required.

1.4 REFERENCE STANDARDS

A. Federal Specifications

1. QQ-W-461H - Wire, Steel, and Carbon (round, bare and coated)

B. American Concrete Institute (ACI)

1. ACI 301 - Specifications for Structural Concrete
2. ACI 315 - Details and Detailing of Concrete Reinforcement
3. ACI 318 - Building Code Requirements for Structural Concrete
4. ACI SP-66 - ACI Detailing Manual

C. ASTM International (ASTM)

1. ASTM A615 - Standard Specification for Deformed and Plain Carbon Steel - Bars for Concrete Reinforcement
2. ASTM A706 - Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
3. ASTM A1064 - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
4. ASTM C1116 - Standard Specification for Fiber Reinforced Concrete

D. American Welding Society (AWS)

1. AWS D1.4 - Structural Welding Code - Reinforcing Steel

E. Concrete Reinforcing Steel Institute (CRSI)

1. CRSI - Manual of Standard Practice

F. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.5 QUALITY ASSURANCE

- A. In no case shall any reinforcing steel be covered with concrete until the installation of the reinforcement, including the size, spacing, and position of the reinforcement has been observed by the Engineer and the Engineer's release to proceed with concreting has been obtained. The Engineer shall be given ample prior notice of the readiness of placed reinforcement for observation. The forms shall be kept open until the Engineer has completed observations of the reinforcing steel.

1.6 DELIVERY, HANDLING, AND STORAGE

- A. Reinforcing steel shall be substantially free from mill scale, rust, dirt, grease, or other foreign matter.
- B. Reinforcing steel shall be shipped and stored with bars of the same size and shape, fastened in bundles with durable tags, marked in a legible manner with waterproof markings showing the same "mark" designations as those shown on the submitted placement drawings.
- C. Reinforcing steel shall be stored off the ground, protected from moisture, and kept free from dirt, oil, or other injurious contaminants.

1.7 MEASUREMENT AND PAYMENT

- A. Work shall be considered incidental and compensation shall be included in the Contract prices paid for the various items of work and no additional time or compensation be allowed therefor.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configurations desired.

2.2 MATERIALS

- A. Materials shall be new and shall comply with the following material specifications.
- B. Deformed Concrete Reinforcing Bars are to be ASTM A615, Grade 60 deformed bars.
- C. Concrete reinforcing bars required on the Drawings are to be field bent or welded ASTM A706, Grade 60 deformed bars.
- D. Spiral Reinforcement shall comply with the following:
 - 1. ASTM A615, Grade 60 for hot-rolled plain or deformed bars
- E. Welded Steel Wire Fabric shall comply with ASTM A185.
- F. The following alternative materials are allowed:
 - 1. ASTM A615, Grade 60 may be used for ASTM A706 provided the following requirements are satisfied:
 - a. The actual yield strength of the reinforcing steel based on mill tests shall not exceed the specified yield strength by more than 18,000 pounds per square inch (psi). Retests shall not exceed this value by more than an additional 3,000 psi.
 - b. The ratio of the actual ultimate tensile strength to the actual tensile yield strength of the reinforcement shall not be less than 1.25.

- c. The carbon equivalency (CE) of the bars shall be 0.55 or less.

G. Reinforcing Steel Accessories:

1. Plastic protected bar supports shall comply with CRSI Bar Support Specifications, Class 1 - Maximum Protection.
2. Stainless steel protected bar supports shall comply with CRSI Bar Support Specifications, Class 2 - Moderate Protection.
3. Precast concrete block bar supports (dobies) shall comply with CRSI Bar Support Specifications, Precast Block. Block shall have equal or greater compressive strength than the surrounding concrete.

H. Tie Wire:

1. Tie Wires for Reinforcement shall be 16-gauge or heavier, black annealed wire, conforming to Federal Specification QQ-W-461H.

2.3 FABRICATION

- A. Fabrication of reinforcement shall be in compliance with the CRSI Manual of Standard Practice.

- B. Bars shall be cold bent. Bars shall not be straightened or re-bent.

- C. Bars shall be bent around a revolving collar having a diameter of not less than that recommended by ACI 318.

- D. Bar ends that are to be butt-spliced, placed through limited diameter holes in metal, or threaded shall have the applicable end(s) saw-cut. Such ends shall terminate in flat surfaces within 1.5 degrees of a right angle to the axis of the bar.

E. Spirals:

1. Provide a minimum of one and one-half finishing turns at top and bottom, unless otherwise noted.
2. Splices shall be tension lap splices at least 48 bar diameters, but not less than 12 inches in length. Welded splices shall only be used where specifically approved by the Engineer.
3. Provide spacers as recommended by CRSI.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Surface condition, bending, spacing, and tolerances of placement of reinforcement shall comply with CRSI Manual of Standard Practice. The Contractor shall be solely responsible for providing an adequate number of bars and maintaining the spacing and clearances shown on the Drawings.

- B. Except as otherwise noted on the Drawings, the minimum concrete cover for reinforcement shall be as follows:
1. Concrete cast against and permanently exposed to earth: 3 inches
 2. Concrete exposed to soil, water, sludge, and/or weather (including bottom cover of slabs over water): 2 inches
 3. Concrete not exposed to soil, water, sludge, and/or weather:
 - a. Slabs (top and bottom cover), walls, joists, shells, and folded plate members: 1.5 inches
 - b. Beams and columns, primary reinforcement: 2 inches
 - c. Ties, spirals, and stirrups: 1.5 inches
- C. Reinforcement that will be exposed for a considerable length of time after being placed shall be coated with a heavy coat of neat cement slurry.
- D. No reinforcing steel bars shall be welded either during fabrication or erection unless specifically shown on the Drawings or specified herein, or unless prior written approval has been obtained from the Engineer. All bars that have been welded, including tack welds, without such approval shall be immediately removed from the work and replaced at the expense of the Contractor. If welding of reinforcement is approved or specifically called for, it shall comply with AWS D1.4.
- E. Reinforcing steel interfering with the location of other reinforcing steel, conduits, or embedded items may be moved within the specified tolerances or one bar diameter, whichever is greater. Greater displacements of bars to avoid interference shall only be made with the approval of the Engineer. Do not cut reinforcement to install inserts, conduits, mechanical openings, or other items without the prior approval of the Engineer.
- F. Securely support and tie reinforcing steel to prevent movement during concrete placement. Secure dowels in place before placing concrete.
- G. Reinforcing steel bars shall not be field bent except where shown on the Drawings or specifically authorized in writing by the Engineer. If authorized, bars shall be cold-bent around a standard diameter spool as specified within CRSI. Do not heat bars. Closely inspect the reinforcing steel for breaks. If the reinforcing steel is damaged, replace, Cadweld, or otherwise repair as directed by the Engineer. Do not bend reinforcement after it is embedded in concrete unless specifically permitted on the Drawings.

3.2 REINFORCEMENT AROUND OPENINGS

- A. Unless specific additional reinforcement around openings is shown on the Drawings, provide additional reinforcing steel on each side of the opening equivalent to one-half of the cross-sectional area of the reinforcing steel interrupted by the opening. The bars shall have sufficient length to develop bond at each end beyond the opening or penetration.

3.3 SPLICING OF REINFORCEMENT

- A. Splices designated as compression splices on the Drawings shall be 30 bar diameters, but not less than 12 inches, unless otherwise noted.

- B. Tension lap splices shall be provided at all laps in compliance with ACI 318. The length of splices shall conform to the Drawings. Unless otherwise noted on the Drawings, rebar splices shall be contact lap splices. Splices in adjacent bars shall be staggered. Class A splices may be used when 50 percent or less of the bars are spliced within the required lap length. Class B splices shall be used at all other locations.
- C. Except as otherwise indicated on the Drawings, splices in circumferential reinforcement in circular walls shall be Class B tension splices and shall be staggered. Rebar splices shall be contact lap splices. Adjacent bars shall not be spliced within the required lap length.
- D. Install wire fabric in as long lengths as practicable. Splices in welded wire fabric shall be lapped in accordance with the requirements of ACI 318 but not less than 12 inches. The spliced fabrics shall be tied together with wire ties spaced not more than 24 inches on-center and laced with wire of the same diameter as the welded wire fabric. Do not position laps midway between supporting beams, or directly over beams of continuous structures. Offset splices in adjacent widths to prevent continuous splices.
- E. Mechanical reinforcing steel splicers shall be used only where shown on the Drawings. Splices in adjacent bars shall be offset by at least 30 bar diameters, but not less than 24 inches. Mechanical reinforcing splices are only to be used for special splice and dowel conditions approved by the Engineer.

3.4 ACCESSORIES

- A. Determine, provide, and install accessories such as chairs, chair-bars, and the like in sufficient quantities and strength to adequately support the reinforcement and prevent its displacement during the erection of the reinforcement and the placement of concrete.
- B. Use precast concrete blocks (dobies) where the reinforcing steel is to be supported over soil. In no case shall such supports be continuous.
- C. Stainless steel bar supports or steel chairs with stainless steel tips shall be used where the chairs are set on forms for a concrete surface that will be exposed to weather, high humidity, or liquid (including bottom of slabs over liquid-containing areas). Use of galvanized or plastic-tipped metal chairs is permissible in all other locations unless otherwise noted on the Drawings or specified herein.
- D. Alternate methods of supporting top steel in slabs, such as steel channels supported on the bottom steel or vertical reinforcing steel fasteners to the bottom and top mats may only be used if approved by the Engineer.

END OF SECTION

SECTION 03300 – CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Furnish all labor and materials required and install all cast-in-place concrete complete as shown on the Drawings and as specified herein.
- B. Furnish all sampling and testing of products and materials by an independent testing laboratory acceptable to the ENGINEER but engaged by and at the expense of the CONTRACTOR.

1.2 RELATED WORK

- A. Related Work Specified Elsewhere:
 - 1. Section 03100, Concrete Formwork.
 - 2. Section 03150, Concrete Joints and Joint Accessories.
 - 3. Section 03200, Concrete Reinforcement.
 - 4. Section 03600, Grout.

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. American Concrete Institute (ACI)
 - 1. ACI 304R – Guide for Measuring, Mixing, Transporting, and Placing Concrete.
 - 2. ACI 305R – Guide to Hot Weather Concreting.
 - 3. ACI 306.1 - Standard Specification for Cold Weather Concreting.
 - 4. ACI 315 - Details and Detailing of Concrete Reinforcement.
 - 5. ACI 318 - Building Code Requirements for Structural Concrete.
- B. ASTM International (ASTM)
 - 1. ASTM C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
 - 2. ASTM C33 - Standard Specification for Concrete Aggregates.
 - 3. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
 - 4. ASTM C42 - Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
 - 5. ASTM C94 - Standard Specification for Ready-Mixed Concrete.

6. ASTM C143 - Standard Test Method for Slump of Hydraulic Cement Concrete.
7. ASTM C150 - Standard Specification for Portland Cement.
8. ASTM C157 - Standard Test Method for Length Change of Hardened Hydraulic Cement Mortar and Concrete.
9. ASTM C171 - Standard Specification for Sheet Materials for Curing Concrete.
10. ASTM C173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
11. ASTM C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
12. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
13. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
14. ASTM C311 - Standard Test Methods for Sampling and Testing Fly-Ash or Natural Pozzolans for Use in Portland-Cement Concrete.
15. ASTM C494 - Standard Specification for Chemical Admixtures for Concrete.
16. ASTM C596 - Standard Test Method for Drying Shrinkage of Mortar Containing Hydraulic Cement.
17. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for use in Concrete.
18. ASTM C1017 - Standard Specification for Chemical Admixtures for use in Producing Flowing Concrete.

- C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.4 SUBMITTALS

- A. Submit to the ENGINEER, in accordance with Division 1, submittals including the following:
1. Sources of cement, pozzolan, and aggregates.
 2. Safety Data Sheets (SDS) for all concrete components and admixtures.
 3. Air-entraining admixture. Product data including catalogue cut, technical data, storage requirements, product life, recommended dosage, temperature considerations, and conformity to ASTM standards.
 4. Water reducing admixture. Product data including catalogue cut, technical data, storage requirements, product life, recommended dosage, temperature considerations, and conformity to ASTM standards.

5. High range water reducing admixture. Product data including catalogue cut, technical data, storage requirements, product life, recommended dosage, temperature considerations, retarding effect, slump range and conformity to ASTM standards. Identify proposed locations for use.
6. Concrete mix design for each formulation of concrete proposed for use including constituent quantities per cubic yard, water-cementitious materials ratio, type and manufacturer of cement, compressive strength, concrete slump, shrinkage, and air content. Provide with (a) or (b) below for each mix proposed.
 - a. Standard deviation data for each proposed concrete mix based on statistical records, OR,
 - b. The curve of water-cementitious materials ratio versus concrete cylinder strength for each formulation of concrete proposed based on laboratory tests. The cylinder strength shall be the average of the 28-day cylinder strength test results for each mix. Provide results of 7 and 14 day tests if available.
7. Sheet curing material. Product data including catalogue cut, technical data and conformity to ASTM standards.
8. Liquid curing compound. Product data including catalogue cut, technical data, storage requirements, product life, application rate and conformity to ASTM standards. Identify proposed locations of use.
9. Samples – Fine and coarse aggregates if requested by the ENGINEER.
10. Test Reports – Submit test reports for each of the following items.
 - a. Fine aggregates – sieve analysis, physical properties, and deleterious substance.
 - b. Coarse aggregates – sieve analysis, physical properties, and deleterious substance.
 - c. Cements – chemical analysis and physical properties for each type.
 - d. Pozzolans – chemical analysis and physical properties.
11. Certifications:
 - a. Certify that admixtures used in the same concrete mix are compatible with each other and the aggregates.
 - b. Certify the Contractor is not associated with the independent testing laboratory nor does the Contractor or its officers have a beneficial interest in the laboratory.
12. Shrinkage test reports.
13. Work Plans:
 - a. Hot weather concreting.

- b. Cold weather concreting.

1.5 QUALITY ASSURANCE

- A. Reinforced concrete shall comply with ACI 318, and other stated requirements, codes and standards. The most stringent requirement of the codes, standards and this Section shall apply when conflicts arise.
- B. Only one source of cement and aggregate shall be used on any one structure. Concrete shall be uniform in color and appearance.
- C. Well in advance of placing concrete, discuss with the ENGINEER the sources of individual materials and batched concrete proposed for use. Discuss placement methods, waterstops, and curing. Propose methods of hot and cold weather concreting as required.
- D. A meeting shall be held prior to placement of plasticized concrete. The plasticizer (high range water reducer) manufacturer's representative and the Contractor shall be available to discuss the properties and techniques of batching and placing plasticized concrete.
- E. If, during the progress of the work, it is impossible to secure concrete of the required workability and strength with the materials being furnished, the ENGINEER may order such changes in proportions or materials, or both, as may be necessary to secure the desired properties. All changes so ordered shall be made at the CONTRACTOR's expense.
- F. If, during the progress of work, the materials from the sources originally accepted change in characteristics, the CONTRACTOR shall, at their expense, make new acceptance tests of aggregates and establish new design mixes.
- G. Testing of the following materials shall be furnished by the CONTRACTOR to verify conformity with this Specification Section and the stated ASTM Standard(s).
 - 1. Fine aggregates for conformity to ASTM C33 – sieve analysis, physical properties, and deleterious substances.
 - 2. Coarse aggregates for conformity to ASTM C33 – sieve analysis, physical properties, and deleterious substances.
 - 3. Cements for conformity to ASTM C150 – chemical analysis and physical properties.
 - 4. Pozzolans for conformity to ASTM C618 – chemical analysis and physical properties.
 - 5. Proposed concrete mix design(s) – compressive strength, slump, shrinkage, and air content.
- H. The OWNER will provide field-testing and inspection services. The cost of such work, except as specifically stated otherwise, shall be paid by the OWNER. Testing of the following items shall be by the OWNER to verify conformity with this Specification Section.
 - 1. Concrete placement – compressive strength (cylinders), compressive strength (cores), slump, air content, and shrinkage.
 - 2. Other materials or products that may come under question.

- I. All materials incorporated in the work shall conform to accepted samples.
- 1.6 DELIVERY, HANDLING AND STORAGE
- A. Cement – Store in weather tight buildings, bins, or silos to provide protection from dampness and contamination and to minimize warehouse set.
 - B. Aggregate – Arrange and use stockpiles to avoid excessive segregation or contamination with other materials or with other sizes of like aggregates. Do not use frozen or partially frozen aggregate.
 - C. Sand – Arrange and use stockpiles to avoid contamination. Allow sand to drain to uniform moisture content before using. Do not use frozen or partially frozen sands.
 - D. Admixtures – Store in closed containers to avoid contamination, evaporation, or damage. Provide suitable agitating equipment to assure uniform dispersion of ingredients in admixture solutions that tend to separate. Protect liquid admixtures from freezing and other temperature changes that could adversely affect their characteristics.
 - E. Pozzolan – Store in weather tight buildings, bins, or silos to provide protection from dampness and contamination.
 - F. Sheet Curing Materials – Store in weather tight buildings or off the ground and under cover.
 - G. Liquid curing compounds – Store in closed containers.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.
- B. Like items of materials shall be the end products of one manufacturer in order to provide standardization for appearance, maintenance and manufacturer's services.

2.2 MATERIALS

- A. Materials shall comply with this Section and any applicable State or Local requirements.
- B. Cement – Domestic Portland cement complying with ASTM C150 Type I or II. Air entraining cement shall not be used. Cement brand shall be subject to approval by the ENGINEER and one brand shall be used throughout the Work.
- C. Fine Aggregates – Washed inert natural sand conforming to the requirements of ASTM C33.
- D. Coarse Aggregates – Well-graded crushed stone or washed gravel conforming to the requirements of ASTM C33. Grading requirements shall be as listed in ASTM C33 Table 2 for the specified coarse aggregate size number. Limits of Deleterious Substances and Physical Property Requirements shall be as listed in ASTM C33 Table 3 for severe weathering regions. Size numbers for concrete mixes shall be as shown in Table 1 herein.

- E. Water – Potable water free from injurious amounts of oil, acids, alkalis, salts, organic matter, or other deleterious substances. Use of reclaimed or recycled process water is not permitted.
- F. Admixtures – Admixtures shall be free of chlorides and alkalis (except for those attributable to water). When it is required to use more than one admixture in a concrete mix, the admixtures shall be from the same manufacturer. Admixtures shall be compatible with the concrete mix including other admixtures.
 - 1. Air Entraining Admixture – The admixture shall comply with ASTM C260. Proportioning and mixing shall be in accordance with manufacturer's recommendations.
 - 2. Admixtures causing retarded or accelerated setting of concrete shall not be used without written approval from the ENGINEER. When allowed, the admixtures shall be retarding or accelerating water reducing or high range water reducing admixtures.
 - 3. Water-Reducing Admixture – The admixture shall comply with ASTM C494, Type A. Proportioning and mixing shall be in accordance with manufacturer's recommendations.
 - 4. High-Range Water Reducer (Plasticizer) – The admixture shall comply with ASTM C494, Type F and shall result in non-segregating plasticized concrete with little bleeding and with the physical properties of low water/cement ratio concrete. The treated concrete shall be capable of maintaining its plastic state in excess of 2 hours. Proportioning and mixing shall be in accordance with manufacturer's recommendations.
- G. Pozzolan (Fly Ash) – Pozzolan shall be Class F fly ash complying with ASTM C618, except the Loss On Ignition (LOI) shall be limited to 3 percent maximum. Use of Class C or Class N fly ash is not permitted.
- H. Sheet Curing Material – waterproof paper, polyethylene film or white burlap-polyethylene sheeting, all which must comply with ASTM C171.
- I. Liquid Curing Compound – Liquid membrane-forming curing compound shall comply with the requirements of ASTM C309, Type 1-D (clear or translucent with fugitive dye) and shall contain no wax, paraffin, or oil.

2.3 CONCRETE MIXES

- A. Development of mix designs and testing shall be by an independent testing laboratory acceptable to the ENGINEER engaged by and at the expense of the CONTRACTOR.
- B. Select proportions of ingredients to meet the design strength and materials limits specified in Table 1 and to produce concrete having proper placability, durability, strength, appearance and other required properties. Proportion ingredients to produce a homogenous mixture that will readily work into corners and angles of forms and around reinforcement without permitting materials to segregate or allowing excessive free water to collect on the surface.
- C. The design mix shall be based on standard deviation data of prior mixes with essentially the same proportions of the same constituents or, if such data is not available, be developed by a testing laboratory, acceptable to the ENGINEER, engaged by and at the

expense of the CONTRACTOR. Acceptance of mixes based on standard deviation shall be based on the modification factors for standard deviation tests contained in ACI 318. The water content of the concrete mix, determined by laboratory testing, shall be based on a curve showing the relation between water cementitious ratio and 7 and 28 day compressive strengths of concrete made using the proposed materials. The curves shall be determined by four or more points, each representing an average value of at least three test specimens at each age. The curves shall have a range of values sufficient to yield the desired data, including the specified design strengths as modified below, without extrapolation. The water content of the concrete mixes to be used, as determined from the curve, shall correspond to strengths 16 percent greater than the specified design strengths. The resulting mix shall not conflict with the limiting values for maximum water cementitious ratio and net minimum cementitious content as specified in Table 1.

- D. Compression Tests – Provide testing of the proposed concrete mix or mixes to demonstrate compliance with the specified design strength requirements in conformity with the above paragraph.
- E. Shrinkage Tests – Perform shrinkage tests for Class D concrete. The tests shall conform to ASTM C157 as modified by ASTM C596. Concrete and not mortar specimens shall be used.
 - 1. The average shrinkage at 25 days of air storage shall not exceed 0.036 percent.
- F. Entrained air, as measured by ASTM C231, shall be as shown in Table 1.
 - 1. If the air entraining agent proposed for use in the mix requires testing methods other than ASTM C231 to accurately determine air content, make special note of this requirement in the admixture submittal.
- G. Slump of the concrete as measured by ASTM C143, shall be as shown in Table 1. If a high-range water-reducer (plasticizer) is used, the slump indicated shall be that measured before plasticizer is added. Plasticized concrete shall have a slump ranging from 7 to 10-in.
- H. Proportion admixtures according to the manufacturer's recommendations. Two or more admixtures specified may be used in the same mix provided that the admixtures in combination retain full efficiency and have no deleterious effect on the concrete or on the properties of each other.

TABLE 1**Concrete Mix Requirements**

<u>Class</u>	<u>Design Strength</u> (1)	<u>Cement</u> (2)	<u>Fine Aggregate</u> (2)	<u>Coarse Aggregate</u> (3)	<u>Cementitious Content</u> <u>Lbs. (min)</u> (4)
D	4000	C150 Type II	C33	57	560

<u>Class</u>	<u>W/C Ratio (Max.)</u> (5)	<u>Fly Ash</u> (6)	<u>AE Range</u> (7)	<u>WR</u> (8)	<u>HRWR</u> (9)	<u>Slump Range</u> <u>Inches</u>
D	0.42	15-25%	3.5 to 5	Yes	No	3-5

NOTES:

- (1) Minimum compressive strength in psi at 28 days
- (2) ASTM designation
- (3) Size Number in ASTM C33
- (4) Cementitious content in lbs/cu-yd
- (5) W/C is Water-Cementitious ratio by weight
- (6) Percent content of total Cementitious material
- (7) AE is percent air-entrainment
- (8) WR is water-reducer admixture
- (9) HRWR is high-range water-reducer admixture

PART 3 EXECUTION

3.1 MEASURING MATERIALS

- A. Concrete shall be composed of Portland cement, fine aggregate, coarse aggregate, water and admixtures as specified and shall be produced by a plant acceptable to the ENGINEER. All constituents, including admixtures, shall be batched at the plant except a high-range water-reducer may be added in the field.
- B. Measure materials for batching concrete by weighing in conformity with and within the tolerances given in ASTM C94 except as otherwise specified. Scales shall have been certified by the local Sealer of Weights and Measures within one year of use.
- C. Measure the amount of free water in fine aggregates within 0.3 percent with a moisture meter. Compensate for varying moisture contents of fine aggregates. Record the number of gallons of water as batched on printed batching tickets.
- D. Admixtures shall be dispensed either manually using calibrated containers or measuring tanks, or by means of an automatic dispenser approved by the manufacturer of the specific admixture.
 - 1. Charge air-entraining and chemical admixtures into the mixer as a solution using an automatic dispenser or similar metering device.
 - 2. Inject multiple admixtures separately during the batching sequence.

3.2 MIXING AND TRANSPORTATION

- A. Concrete shall be ready-mixed concrete. No hand mixing will be permitted. Clean each transit mix truck drum and reverse drum rotation before the truck proceeds under the batching plant. Equip each transit-mix truck with a continuous, nonreversible, revolution counter showing the number of revolutions at mixing speeds.
- B. Ready-mix concrete shall be transported to the site in watertight agitator or mixer trucks loaded not in excess of their rated capacities as stated on the nameplate.
- C. Keep the water tank valve on each transit truck locked at all times. Any addition of water must be approved by the ENGINEER. Added water shall be incorporated by additional mixing of at least 35 revolutions. All added water shall be metered and the amount of water added shall be shown on each delivery ticket.
- D. All central plant and rolling stock equipment and methods shall comply with ACI 318 and ASTM C94.
- E. Select equipment of size and design to ensure continuous flow of concrete at the delivery end. Metal or metal-lined non-aluminum discharge chutes shall be used and shall have slopes not exceeding 1 vertical to 2 horizontal and not less than 1 vertical to 3 horizontal. Chutes more than 20-ft long and chutes not meeting slope requirements may be used if concrete is discharged into a hopper before distribution.
- F. Retempering (mixing with or without additional cement, aggregate, or water) of concrete or mortar that has reached initial set will not be permitted.
- G. Handle concrete from mixer to placement as quickly as practicable while providing concrete of required quality in the placement area. Dispatch trucks from the batching

plant so they arrive at the work site just before the concrete is required, thus avoiding excessive mixing of concrete while waiting, or delays in placing successive layers of concrete in the forms.

- H. Furnish a delivery ticket for ready mixed concrete to the ENGINEER as each truck arrives. Each ticket shall provide a printed record of the weight of cement and each aggregate as batched individually. Use the type of indicator that returns for zero punch or returns to zero after a batch is discharged. Clearly indicate the weight of fine and coarse aggregate, cement and water in each batch, the quantity delivered, the time any water is added, and the numerical sequence of the delivery. Show the time of day batched and time of discharge from the truck. Indicate the number of revolutions of the truck mixer.

3.3 TEMPERATURE AND MIXING TIME CONTROL

- A. In cold weather, do not allow the as-mixed temperature of the concrete and concrete temperatures at the time of placement in the forms to drop below 40 degrees F.
- B. If water or aggregate has been heated, combine water with aggregate in the mixer before cement is added. Do not add cement to mixtures of water and aggregate when the temperature of the mixture is greater than 90 degrees F.
- C. In hot weather, cool ingredients before mixing to maintain temperature of the concrete below the maximum placing temperature of 90 degrees F. If necessary, substitute well-crushed ice for all or part of the mixing water.
- D. The maximum time interval between the addition of mixing water and/or cement to the batch and the placing of concrete in the forms shall not exceed the values shown in Table 2.
- E. If an approved high-range water-reducer (plasticizer) is used to produce plasticized concrete, the maximum time interval shall not exceed 90 minutes.

Table 2
Maximum Time to Discharge of Concrete

<u>Air or Concrete Temperature</u> <u>(Whichever is higher)</u>	<u>Maximum Time</u> <u>(Minutes)</u>
70 to 90 Degree F (21 to 32 Degree C)	60
40 to 69 Degree F (5 to 20 Degree C)	90

3.4 CONCRETE APPEARANCE

- A. Concrete mix showing either poor cohesion or poor coating of the coarse aggregate with paste shall be remixed. If this does not correct the condition, the concrete shall be rejected. If the slump is within the allowable limit, but excessive bleeding, poor workability, or poor finishability are observed, changes in the concrete mix shall be obtained only by adjusting one or more of the following:
 - 1. The gradation of the aggregate.
 - 2. The proportion of fine and coarse aggregate.

3. The percentage of entrained air, within the allowable limits.

- B. Concrete for the work shall provide a homogeneous structure which, when hardened, will have the required strength, durability and appearance. Mixtures and workmanship shall be such that concrete surfaces, when exposed, will require no finishing. When concrete surfaces are stripped, the concrete, when viewed in good lighting from 10-ft away, shall be pleasing in appearance, and at 20-ft shall show no visible defects.

3.5 PLACING AND COMPACTING

A. Placing:

1. Placing of all concrete shall be in accordance with the recommendations contained in ACI 304R.
2. Verify that all formwork completely encloses concrete to be placed and is securely braced prior to concrete placement. Remove ice, excess water, dirt and other foreign materials from forms. Confirm that reinforcement and other embedded items are securely in place. Have a competent worker at the location of the placement that can assure that reinforcing steel and embedded items remain in designated locations while concrete is being placed. Sprinkle semi-porous sub grades or forms to eliminate suction of water from the mix. Seal extremely porous sub grades in an approved manner.
3. Deposit concrete as near to its final position as possible to avoid segregation due to rehandling or flowing. Place concrete continuously at a rate that ensures the concrete is being integrated with fresh plastic concrete. Do not deposit concrete that has partially hardened or has been contaminated by foreign materials or on concrete that has hardened sufficiently to cause formation of seams or planes of weakness within the section. If the section cannot be placed continuously, place construction joints as specified or as approved.
4. Pumping of concrete will be permitted. Use a mix design and aggregate sizes suitable for pumping and submit for approval.
5. Remove temporary spreaders from forms when the spreader is no longer useful. Temporary spreaders may remain embedded in concrete only when made of galvanized metal or concrete and if prior approval has been obtained.
6. Do not place concrete for supported elements until concrete previously placed in the supporting element (slabs and/or walls) has reached adequate strength.

B. Slabs:

1. After suitable bulkheads, screeds and jointing materials have been positioned, the concrete shall be placed continuously between construction joints beginning at a bulkhead, edge form, or corner. Each batch shall be placed into the edge of the previously placed concrete to avoid stone pockets and segregation.
2. Avoid delays in casting. If there is a delay in casting, the concrete placed after the delay shall be thoroughly spaded and consolidated at the edge of that previously placed to avoid cold joints. Concrete shall then be brought to correct level and struck off with a straightedge. Bullfloats or darbies shall be used to smooth the surface, leaving it free of humps or hollows.

3. "Jitterbugs" shall not be used on slab surfaces to aid in finishing.
4. Where slabs are to be placed integrally with the walls below them, place the walls and compact as specified. Allow 1 hour to pass between placement of the wall and the overlying slab to permit consolidation of the wall concrete. Keep the top surface of the wall moist so as to prevent cold joints.

C. Formed Concrete:

1. Place concrete in forms using tremie tubes and taking care to prevent segregation. Bottom of tremie tubes shall preferably be in contact with the concrete already placed. Do not permit concrete to drop freely more than 4-ft. Place concrete for walls in 12 to 24-in lifts, keeping the surface horizontal. If plasticized concrete is used, the maximum lift thickness may be increased to 7-ft and the maximum free fall of concrete shall not exceed 15-ft.

D. Compacting:

1. Consolidate concrete by vibration, puddling, spading, rodding or forking so that concrete is thoroughly worked around reinforcement, embedded items and openings and into corners of forms. Puddling, spading, etc, shall be continuously performed along with vibration of the placement to eliminate air or stone pockets that may cause honeycombing, pitting or planes of weakness.
2. All concrete shall be placed and compacted with mechanical vibrators. The number, type and size of the units shall be approved by the ENGINEER in advance of placing operations. No concrete shall be ordered until sufficient approved vibrators (including standby units in working order) are on the job site.
3. A minimum frequency of 7000 rpm is required for mechanical vibrators. Insert and withdraw vibrators vertically at points from 18 to 30-in apart. At each insertion, vibrate sufficiently to consolidate concrete, generally from 5 to 15 seconds. Do not over-vibrate so as to segregate. Keep a spare vibrator on the site during concrete placing operations.
4. Concrete Slabs – Concrete for slabs less than 8-in thick shall be consolidated with vibrating screeds; slabs 8 to 12-in thick shall be compacted with internal vibrators and (optionally) with vibrating screeds. Vibrators shall always be placed into concrete vertically and shall not be laid horizontally or laid over.
5. Walls – Internal vibrators (rather than form vibrators) shall be used unless otherwise approved by the ENGINEER. In general, for each vibrator needed to melt down the batch at the point of discharge, one or more additional vibrators must be used to densify, homogenize and perfect the surface. The vibrators shall be inserted vertically at regular intervals, through the fresh concrete and slightly into the previous lift, if any.
6. Amount of Vibration: Vibrators are to be used to consolidate properly placed concrete but shall not be used to move or transport concrete in the forms. Vibration shall continue until:
 - a. Frequency returns to normal.
 - b. Surface appears liquefied, flattened and glistening.

- c. Trapped air ceases to rise.
- d. Coarse aggregate has blended into surface, but has not disappeared.

3.6 CURING AND PROTECTION

- A. Protect all concrete work against injury from the elements and defacements of any nature during construction operations.
- B. Curing Methods:
 - 1. Curing Methods for Concrete Surfaces – Cure concrete to retain moisture and maintain specified temperature at the surface for a minimum of 7 days after placement. Curing methods to be used are as follows:
 - a. Water Curing – Keep entire concrete surface wet by ponding, continuous sprinkling or covered with saturated burlap. Begin wet cure as soon as concrete attains an initial set and maintain wet cure 24 hours a day.
 - b. Sheet Material Curing – Cover entire surface with sheet material. Securely anchor sheeting to prevent wind and air from lifting the sheeting or entrapping air under the sheet. Place and secure sheet as soon as initial concrete set occurs.
 - c. Liquid Membrane Curing – Apply over the entire concrete surface except for surfaces to receive additional concrete. Curing compound shall NOT be placed on any concrete surface where additional concrete is to be placed, where concrete sealers or surface coatings are to be used, or where the concrete finish requires an integral floor product. Curing compound shall be applied as soon as the free water on the surface has disappeared and no water sheen is visible, but not after the concrete is dry or when the curing compound can be absorbed into the concrete. Application shall be in compliance with the manufacturer's recommendations.
- C. Specified Applications of Curing Methods:
 - 1. Slabs for Water Containment Structures – Water curing only.
 - 2. Slabs on Grade and Footings (not used to contain water) – Water curing, sheet material curing, or liquid membrane curing.
 - 3. Structural Slabs (other than water containment) – Water curing or liquid membrane curing.
 - 4. Horizontal Surfaces which will Receive Additional Concrete, Coatings, Grout or Other Material that Requires Bond to the substrate – Water curing.
 - 5. Formed Surfaces - None if nonabsorbent forms are left in place 7 days. Water cure if absorbent forms are used. Sheet cured or liquid membrane cured if forms are removed prior to 7 days. Exposed horizontal surfaces of formed walls shall be water cured for 7 days or until next placement of concrete is made.
 - 6. Concrete Joints – Water cured or sheet material cured.

- D. Finished surfaces and slabs shall be protected from the direct rays of the sun to prevent checking and crazing.

3.7 REMOVAL OF FORMS

- A. Except as otherwise specifically approved by the ENGINEER, forms shall not be removed before the concrete has attained a strength of at least 30 percent of its specified design strength, nor before reaching 100 Degree-Days of curing for walls and vertical surfaces, and 500 Degree-Days of curing for beams and slabs, (whichever is the longer). Degree-days are defined as the total number of 24 hour periods multiplied by the weighted average daily air temperature at the surface of the concrete (e.g.: 5 days at an average 70 degrees F = 350 degree-days).
- B. Shores shall not be removed until the concrete has attained at least 60 percent of its specified design strength and also sufficient strength to support safely its own weight and construction live loads.

3.8 INSPECTION AND FIELD TESTING

- A. The batching, mixing, transporting, placing and curing of concrete shall be subject to the inspection of the ENGINEER at all times. The CONTRACTOR shall advise the ENGINEER of their readiness to proceed at least 24 hours prior to each concrete placement. The ENGINEER will inspect the preparations for concreting including the preparation of previously placed concrete, the reinforcing steel and the alignment, cleanliness and tightness of formwork. No placement shall be made without the inspection and acceptance of the ENGINEER.
- B. Sets of field control cylinder specimens will be taken by an independent entity paid for by the OWNER during the progress of the work, in compliance with ASTM C31. The number of sets of concrete test cylinders taken of each class of concrete placed each day shall not be less than one set per day, nor less than one set for each 150 cu-yds of concrete nor less than one set for each 3,000 sq ft of surface area for slabs or walls. If the total volume of concrete were such that the frequency of testing required for a given class of concrete would provide less than five strength tests, tests shall be made from at least five randomly selected batches or from each batch if fewer than five batches are anticipated.
- C. A "set" of test cylinders consists of six cylinders: two to be tested at seven days and two to be tested and their strengths averaged at 28 days. The final two may be used for a special test at three days or to verify strength after 28 days if 28-day test results are low. CONTRACTOR shall provide a copy of all concrete test results to the OWNER for their review.
- D. When the average 28 day compressive strength of the cylinders in any set falls below the specified design strength or below proportional minimum seven day strengths (where proper relation between seven and 28 day strengths have been established by tests), proportions, water content, or temperature conditions shall be changed to achieve the required strengths.
- E. The CONTRACTOR shall cooperate in the making of tests by allowing free access to the work for the selection of samples, providing an insulated closed curing box for specimens, affording protection to the specimens against injury or loss through the operations and furnish material and labor required for the purpose of taking concrete

cylinder samples. All shipping of specimens will be paid for by the OWNER. Curing boxes shall be acceptable to the ENGINEER.

F. Concrete Slump:

1. Slump tests will be made in the field immediately prior to placing the concrete by an independent entity paid for by the OWNER. Such tests shall be made in accordance with ASTM C143. If the slump is greater than the specified range, the concrete shall be rejected.
2. At a minimum the first three trucks shall be tested to establish consistency. Additionally, testing will be performed with each strength test (cylinders) and each air-entrainment test.
3. The ENGINEER reserves the right to increase the frequency of testing when deemed necessary.

G. Air Content:

1. Test for air content (entrapped + entrained) shall be made on a fresh concrete sample by an independent entity paid for by the OWNER. Air content for concrete made of ordinary aggregates having low absorption shall be made in compliance with either the pressure method complying with ASTM C231 or by the volumetric method complying with ASTM C173. If lightweight aggregates or aggregates with high absorptions are used, the latter test method shall be used. If air content is below the specified range air-entraining admixture may be added on-site to bring the concrete within specifications. If air content (entrapped + entrained) is above the specified range, the concrete shall be rejected.
2. At a minimum, the first three trucks shall be tested to establish consistency, then every third truck thereafter. Additionally, an air-entrainment test shall be performed with each strength test (cylinders). Concrete samples for the testing of air-entrainment shall be taken at the point of placement and not at the truck chute/hopper.
3. The ENGINEER reserves the right to increase the frequency of testing when deemed necessary.

H. Shrinkage:

1. Field shrinkage specimens shall be taken and tested by an independent entity paid for by the OWNER during the progress of the work.
2. Field test specimens of concrete for water containment structures, shall be taken with each strength test sampling (cylinders).
3. The maximum concrete shrinkage for specimens cast in the field shall not exceed the trial batch maximum shrinkage requirement by more than 25 percent.
4. If the required shrinkage limitation is not met during construction, the CONTRACTOR shall take any or all of the following actions, at no additional cost to the OWNER, to achieve the specified shrinkage requirements. These actions may include changing the source of aggregates, cement and/or admixtures; reducing water content; washing of aggregate to reduce fines; increasing the

number of construction joints; modifying the curing requirements; or other actions designed to minimize shrinkage or the effects of shrinkage.

- I. The ENGINEER may have cores taken from any questionable area in the concrete work such as construction joints and other locations as required for determination of concrete quality. The results of tests on such cores shall be the basis for acceptance, rejection or determining the continuation of concrete work.
- J. The CONTRACTOR shall cooperate in obtaining cores by allowing free access to the work and permitting the use of ladders, scaffolding and such incidental equipment as may be required. Repair all core holes. The work of cutting and testing the cores will be at the expense of the OWNER.

3.9 FAILURE TO MEET REQUIREMENTS

- A. Should the strengths shown by test specimens made and tested in compliance with the previous provisions fall below the values given in Table 1, the ENGINEER shall have the right to require changes in proportions outlined to apply to the remainder of the work. Furthermore, the ENGINEER shall have the right to require additional curing on those portions of the structure represented by the test specimens that failed. The cost of such additional curing shall be at the CONTRACTOR's expense. In the event that such additional curing does not give the strength required, as evidenced by core and/or load tests, the ENGINEER shall have the right to require strengthening or replacement of those portions of the structure which fail to develop the required strength. The cost of all such core borings and/or load tests and any strengthening or concrete replacement required because strengths of test specimens are below that specified, shall be entirely at the expense of the CONTRACTOR. In such cases of failure to meet strength requirements, the CONTRACTOR and ENGINEER shall confer to determine what adjustment, if any, can be made in compliance with Sections titled "Strength" and "Failure to Meet Strength Requirements" of ASTM C94. The "purchaser" referred to in ASTM C94 is the CONTRACTOR in this Section.
- B. When the tests on field control specimens of concrete fall below the specified strength, the ENGINEER will permit check tests for strengths to be made by means of typical cores drilled from the structure in compliance with ASTM C42 and C39. In the case of cores not indicating adequate strength, the ENGINEER, in addition to other recourses, may require, at the CONTRACTOR's expense, load tests on any one of the elements in which such concrete was used. Tests need not be made until concrete has aged 60 days.
- C. Should the strength of test cylinders fall below 60 percent of the required minimum 28-day strength, the concrete shall be rejected and shall be removed and replaced.

3.10 PATCHING AND REPAIRING

- A. It is the intent of this Section to require quality work including adequate forming, proper mixture and placement of concrete and curing so completed concrete surfaces will require no patching.
- B. Defective concrete and honeycombed areas shall be repaired as directed by the ENGINEER.
- C. As soon as forms have been removed and the concrete surfaces exposed, fins and other projections shall be removed. All exposed surfaces shall be carefully examined and any irregularities shall be immediately rubbed or ground in a satisfactory manner in order to secure a smooth, uniform and continuous surface. Plastering or coating of surfaces to be

smoothed will not be permitted. No repairs shall be made until after inspection by the ENGINEER. In no case will extensive patching of honeycombed concrete be permitted. Concrete containing minor voids, holes, honeycombing, or similar depression defects shall be repaired as specified herein. Concrete containing extensive voids, holes, honeycombing, or similar depression defects, shall be completely removed and replaced. The CONTRACTOR, at their own expense, shall promptly execute all repairs and replacements herein specified.

- D. Defective surfaces to be repaired as specified in Paragraph C shall be cut back from true line a minimum depth of ½-inch over the entire area. Feathered edges will not be permitted. Where chipping or cutting tools are not required in order to deepen the area properly, the surface shall be prepared for bonding by the removal of all laitance or soft material and not less than 1/32-inch depth of the surface film from all hard portions, by means of an efficient sandblast. After cutting and sandblasting, the surface shall be wetted sufficiently in advance of shooting with shotcrete or with cement mortar so that while the repair material is being applied, the surfaces under repair will remain moist, but not so wet as to overcome the suction upon which a good bond depends. The material used for the repair proposed shall contain such proportion of Atlas white Portland Cement as is required to make the color of the patch match the color of the surrounding concrete.
- E. Recesses left by the removal of form ties shall be filled. Immediately after removal of forms, remove plugs and break off metal ties as required by Section 03100. Promptly fill holes upon stripping as follows: Moisten the hole with water, followed by a 1/16-in brush coat of neat cement slurry mixed to the consistency of a heavy paste. Immediately plug the hole with a 1 to 1.5 mixture of cement and concrete sand mixed slightly damp to the touch (just short of "balling"). Hammer the grout into the hole until dense, and an excess of paste appears on the surface in the form of a spider web. Trowel smooth with heavy pressure. Avoid burnishing.
- F. Surface defects which do not impair structural strength shall be repaired. When patching exposed surfaces the same source of cement and sand as used in the parent concrete shall be employed. Adjust color if necessary by addition of proper amounts of white cement. Rub lightly with fine Carborundum stone at an age of one to five days if necessary to bring the surface down with the parent concrete. Exercise care to avoid damaging or staining the virgin skin of the surrounding parent concrete. Wash thoroughly to remove all rubbed matter.
- G. Clean all exposed concrete surfaces and adjoining work stained by leakage of concrete.

3.11 SCHEDULE

- A. The following (Table 3) are the general applications for the various concrete classes and design strengths.

Table 3
Concrete Schedule

Class	Design Strength	Description
A	2,500	Concrete fill and duct encasement
B	3,000	Concrete overlay slabs and pavements
C	N/A	Not used
D	4,000	Walls, slabs on grade, suspended slab and beam systems, grade beams and all other structural concrete

END OF SECTION

SECTION 03600 – GROUT

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Furnish all labor, materials, equipment and incidentals required and install grout complete as shown on the Drawings and as specified herein.
- B. Perform all sampling and furnish all testing of materials and products by an independent testing laboratory acceptable to the ENGINEER but engaged by and at the expense of the OWNER.

1.2 RELATED WORK

- A. Related Work Specified Elsewhere:
 - 1. Section 03100, Concrete Formwork.
 - 2. Section 03150, Concrete Joints and Joint Accessories.
 - 3. Section 03200, Concrete Reinforcement.
 - 4. Section 03300, Cast-in-Place Concrete.
 - 5. Section 05500, Miscellaneous Metals.

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. ASTM International (ASTM)
 - 1. ASTM C531 - Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical Resistant Mortars, Grouts and Monolithic Surfacing and Polymer Concretes.
 - 2. ASTM C579 - Standard Test Method for Compressive Strength of Chemical Resistant Mortars, Grouts and Monolithic Surfacing and Polymer Concretes.
 - 3. ASTM C827 - Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures.
 - 4. ASTM C1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
 - 5. ASTM D695 - Standard Test Method for Compressive Properties of Rigid Plastics.
- B. US Army Corps of Engineers (CRD)
 - 1. CRD-C 621 - Corps of Engineers Specification for Nonshrink Grout.
- C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.4 SUBMITTALS

- A. Submit to the ENGINEER, in accordance with Division 1, submittals including the following:
 - 1. Commercially Manufactured Nonshrink Cementitious Grout – product data including catalogue cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, conformity to required ASTM standards and Safety Data Sheet.
 - 2. Commercially Manufactured Nonshrink Epoxy Grout– product data including catalogue cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, conformity to required ASTM standards and Safety Data Sheet.
 - 3. Concrete Grout – the submittal shall include data as required for concrete as delineated in Section 03300 and for fiber reinforcement as delineated in Section 03200. This includes the mix design, constituent quantities per cubic yard and the water/cementitious ratio.
- B. Samples:
 - 1. Samples of commercially manufactured grout products when requested by the ENGINEER.
 - 2. Aggregates for use in concrete grout when requested by the ENGINEER.
- C. Laboratory Test Reports:
 - 1. Submit laboratory test data as required under Section 03300 for concrete to be used as concrete grout.
- D. Certifications:
 - 1. Certify that the CONTRACTOR is not associated with the independent testing laboratory, nor does the CONTRACTOR or its officers have a beneficial interest in the laboratory.

1.5 QUALITY ASSURANCE

- A. Qualifications – Grout manufacturer shall have a minimum of 10 years experience in the production and use of the type of grout proposed for the work.
- B. Pre-Installation Conference – Well in advance of grouting, hold a pre-installation meeting to review the requirements for surface preparation, mixing, placing and curing procedures for each product proposed for use. Parties concerned with grouting shall be notified of the meeting at least 10 days prior to its scheduled date.
- C. Services of Manufacturer's Representative – A qualified field technician of the nonshrink grout manufacturer, specifically trained in the installation of the products, shall attend type of nonshrink grout. Additional services shall also be provided, as required, to correct installation problems.
- D. Field Testing – The field testing of Concrete Grout shall be as specified for concrete in Section 03300.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials to the jobsite in original, unopened packages, clearly labeled with the manufacturer's name, product identification, batch numbers and printed instructions.
- B. Store materials in full compliance with the manufacturer's recommendations. Total storage time from date of manufacture to date of installation shall be limited to six months or the manufacturer's recommended storage time, whichever is less.
- C. Material that becomes damp or otherwise unacceptable shall be immediately removed from the site and replaced with acceptable material at no additional expense to the OWNER.
- D. Nonshrink cement-based grouts shall be delivered as pre-blended, prepackaged mixes requiring only the addition of water.
- E. Nonshrink epoxy grouts shall be delivered as pre-measured, prepackaged, three component systems requiring only blending as directed by the manufacturer.

1.7 DEFINITIONS

- A. Nonshrink Grout – A commercially manufactured product that does not shrink in either the plastic or hardened state, is dimensionally stable in the hardened state and bonds to a clean base plate.

PART 2 PRODUCTS

2.1 GENERAL

- A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.
- B. All like materials shall be the products of one manufacturer or supplier in order to provide standardization of appearance.

2.2 MATERIALS

- A. Nonshrink Cementitious Grout:
 - 1. Nonshrink cementitious grouts shall meet or exceed the requirements of ASTM C1107, Grades B or C and CRD-C 621. Grouts shall be Portland cement based, contain a pre-proportioned blend of selected aggregates and shrinkage compensating agents and shall require only the addition of water. Nonshrink cementitious grouts shall not contain expansive cement or metallic particles. The grouts shall exhibit no shrinkage when tested in conformity with ASTM C827. The minimum 28-day compressive strength of 5,000 psi is required for all non-shrink cementitious grout.
 - 2. General purpose nonshrink cementitious grout shall conform to the standards stated above and shall be SikaGrout 212 by Sika Corp.; NS Grout by The Euclid Chemical Co.; FSP Construction Grout by Five Star Products Inc.; or equal.
 - 3. Flowable (Precision) nonshrink cementitious grout shall conform to the standards stated above and shall be Masterflow 928 by BASF Building Systems; Hi-Flow

Grout by the Euclid Chemical Co.; SikaGrout 212 by Sika Corp.; Five Star Grout, by Five Star Products Inc.; or equal.

B. Non-Shrink Epoxy Grout:

1. Nonshrink epoxy-based grout shall be a pre-proportioned, three component, 100 percent solids system consisting of epoxy resin, hardener, and blended aggregate. It shall have a minimum compressive strength of 10,000 psi in seven days when tested in accordance with ASTM C579, Method B, and have a maximum thermal expansion of 30×10^{-6} when tested in accordance with ASTM C531. The grout shall be Masterflow 648 CP by BASF Building Systems; Five Star HP Epoxy Grout by Five Star Products, Inc.; Sikadur 42 Grout-Pak by Sika Corp.; E3-HP by the Euclid Chemical Co.; or equal.

C. Concrete Grout:

1. Concrete grout shall conform to the requirements of Section 03300 except as specified herein. It shall be proportioned with cement, [pozzolan], coarse and fine aggregates, water, and water reducer to produce a mix having an average strength of 2900 psi at 28 days, or 2500 psi nominal strength. Coarse aggregate size shall be $3/8$ [1/2]-in maximum. Slump shall not exceed 5-inches and should be as low as practical yet still retain sufficient workability.
2. Synthetic reinforcing fibers as specified in Section 03200 shall be added to the concrete grout mix at the rate of 1.5-pounds of fibers per cubic yard of grout. Fibers shall be added from the manufacturer's premeasured bags and according to the manufacturer's recommendations in a manner which will ensure complete dispersion of the fiber bundles as single monofilaments within the concrete grout.

D. Water:

1. Potable water, free from injurious amounts of oil, acid, alkali, organic matter, or other deleterious substances. Use of reclaimed or recycled water is not permitted.

PART 3 EXECUTION

3.1 PREPARATION

- A. Grout shall be placed over cured concrete that has attained its full design strength unless otherwise approved by the ENGINEER.
- B. Concrete surfaces to receive grout shall be clean and sound; free of ice, frost, dirt, grease, oil, curing compounds, laitance and paints and free of all loose material or foreign matter which may affect the bond or performance of the grout.
- C. Roughen concrete surfaces by chipping, sandblasting, or other mechanical means to ensure bond of the grout to the concrete. Remove loose or broken concrete. Irregular voids or projecting coarse aggregate need not be removed if they are sound, free of laitance and firmly embedded into the parent concrete.
 1. Air compressors used to clean surfaces in contact with grout shall be the oil less type or equipped with an oil trap in the airline to prevent oil from being blown onto the surface.

- D. Remove all loose rust, oil or other deleterious substances from metal embedments or bottom of base-plates prior to the installation of the grout.
- E. Epoxy-based grouts do not require the saturation of the concrete substrate. Surfaces in contact with epoxy grout shall be completely dry before grouting.
- F. Construct grout forms or other leak proof containment as required. Forms shall be lined or coated with release agents recommended by the grout manufacturer. Forms shall be of adequate strength, securely anchored in place and shored to resist the forces imposed by the grout and its placement.
 - 1. Forms for epoxy grout shall be designed to allow the formation of a hydraulic head and shall have chamfer strips built into forms.
- G. Level and align the structural or equipment bearing plates in accordance with the structural requirements and the recommendations of the equipment manufacturer.
- H. Equipment shall be supported during alignment and installation of grout by shims, wedges, blocks or other approved means. The shims, wedges and blocking devices shall be prevented from bonding to the grout by appropriate bond breaking coatings and removed after grouting unless otherwise approved by the ENGINEER.

3.2 INSTALLATION – GENERAL

- A. Mix, apply and cure products in strict compliance with the manufacturer's recommendations and this Section.
- B. Have sufficient manpower and equipment available for rapid and continuous mixing and placing. Keep all necessary tools and materials ready and close at hand.
- C. Maintain temperatures of the foundation plate, supporting concrete, and grout between 40 and 90 degrees F during grouting and until grout compressive strength reaches 1000 psi or as recommended by the grout manufacturer, whichever is longer. Take precautions to minimize differential heating or cooling of base plates and grout during the curing period.
- D. Take special precautions for hot weather or cold weather grouting as recommended by the manufacturer when ambient temperatures and/or the temperature of the materials in contact with the grout are outside of the 60 and 90 degrees F range.
- E. Install grout in a manner which will preserve the isolation between the elements on either side of the joint where grout is placed in the vicinity of an expansion or control joint.
- F. Reflect all existing underlying expansion, control and construction joints through the grout.

3.3 INSTALLATION – CEMENT GROUTS AND NONSHRINK CEMENTITIOUS GROUTS

- A. Mix in accordance with manufacturer's recommendations. Do not add cement, sand, pea gravel or admixtures without prior approval by the ENGINEER.
- B. Avoid mixing by hand. Mixing in a mortar mixer (with moving blades) is recommended. Pre-wet the mixer and empty excess water. Add pre-measured amount of water for mixing, followed by the grout. Begin with the minimum amount of water recommended by the manufacturer and then add the minimum additional water required to obtain workability. Do not exceed the manufacturer's maximum recommended water content.

- C. Placements greater than 3-in in depth shall include the addition of clean washed pea gravel to the grout mix when approved by the manufacturer. Comply with the manufacturer's recommendations for the size and amount of aggregate to be added. Place grout into the designated areas in a manner that will avoid segregation or entrapment of air. Do not vibrate grout to release air or to consolidate the material. Placement should proceed in a manner that will ensure the filling of all spaces and provide full contact between the grout and adjoining surfaces. Provide grout holes as necessary.
- D. Place grout rapidly and continuously to avoid cold joints. Do not place cement grouts in layers. Do not add additional water to the mix (retemper) after initial stiffening.
- E. Just before the grout reaches its final set, cut back the grout to the substrate at a 45 degree angle from the lower edge of bearing plate unless otherwise approved by the ENGINEER. Finish this surface with a wood float (brush) finish.
- F. Begin curing immediately after form removal, cutback, and finishing. Keep grout moist and within its recommended placement temperature range for at least 24 hours after placement or longer if recommended by the manufacturer. Saturate the grout surface by use of wet burlap, soaker hoses, ponding or other approved means. Provide sunshades as necessary. If drying winds inhibit the ability of a given curing method to keep grout moist, erect wind breaks until wind is no longer a problem or curing is finished.

3.4 INSTALLATION – NONSHRINK EPOXY GROUTS

- A. Mix in accordance with the procedures recommended by the manufacturer. Do not vary the ratio of components or add solvent to change the consistency of the grout mix. Do not over mix. Mix full batches only to maintain proper proportions of resin, hardener and aggregate.
- B. Monitor ambient weather conditions and contact the grout manufacturer for special placement procedures to be used for temperatures below 60 or above 90 degrees F.
- C. Place grout into the designated areas in a manner that will avoid trapping air. Placement methods shall ensure the filling of all spaces and provide full contact between the grout and adjoining surfaces. Provide grout holes as necessary.
- D. Minimize "shoulder" length (extension of grout horizontally beyond base plate). In no case shall the shoulder length of the grout be greater than the grout thickness.
- E. Finish grout by puddling to cover all aggregate and provide a smooth finish. Break bubbles and smooth the top surface of the grout in conformity with the manufacturer's recommendations.
- F. Epoxy grouts are self-curing and do not require the application of water. Maintain the formed grout within its recommended placement temperature range for at least 24 hours after placing, or longer if recommended by the manufacturer.

3.5 INSTALLATION – CONCRETE GROUT

- A. Screed underlying concrete to the grade shown on the Drawings. Provide the surface with a broomed finish, aligned to drain. Protect and keep the surface clean until placement of the concrete grout.

- B. Remove the debris and clean the surface by sweeping and vacuuming all dirt and other foreign materials. Wash the tank slab using a strong jet of water. Flushing of debris into tank drain lines will not be permitted.
 - C. Saturate the concrete surface for at least 24 hours prior to placement of the concrete grout. Saturation may be maintained by ponding, by the use of soaker hoses, or by other methods acceptable to the ENGINEER. Remove excess water just prior to placement of the concrete grout. Place a cement slurry immediately ahead of the concrete grout so that the slurry is moist when the grout is placed. Work the slurry over the surface with a broom until it is coated with approximately 1/16 to 1/8-in thick cement paste. [(A bonding agent composed of 1 part portland cement, 1.5 parts fine sand, an approved bonding admixture and water, mixed to achieve the consistency of thick paint, may be substituted for the cement slurry.)]
 - D. Place concrete grout to final grade using the scraper mechanism as a guide for surface elevation and to ensure high and low spots are eliminated. Unless specifically approved by the equipment manufacturer, mechanical scraper mechanisms shall not be used as a finishing machine or screed.
 - E. Provide grout control joints as indicated on the Drawings.
 - F. Finish and cure the concrete grout as specified for cast-in-place concrete.
- 3.6 SCHEDULE
- A. General purpose nonshrink cementitious grout: Use at all locations where nonshrink grout is called for on the Drawings except for base plates greater in area than 3-ft wide by 3-ft long and except for the setting of anchor rods, anchor bolts or reinforcing steel in concrete.
 - B. Flowable nonshrink cementitious grout: Use under all base plates greater in area than 3-ft by 3-ft. Use at all locations indicated to receive flowable nonshrink grout on the Drawings. The CONTRACTOR, at his/her option and convenience, may substitute flowable nonshrink grout for general purpose nonshrink cementitious grout.
 - C. Concrete grout: Use for overlaying the base concrete under scraper mechanisms of clarifiers to allow more control in placing the surface grade.

END OF SECTION

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SECTION 05120 – STRUCTURAL STEEL

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. Erection and completion of all structural steel, including all bracing and shoring required for erection and related work. The work shall include and not necessarily be limited to the following:
 - 1. Structural steel, including but not limited to columns, girders, trusses, beams, girts, bracing, anchor bolts, base plates, connection bolts, etc.
 - 2. Anchor bolts shall be furnished under this section and set under Section 03300. Furnish anchor bolts, nuts and metal setting templates. Furnish instructions for the setting of anchor bolts and ascertain that the items are properly set during and after the progress of the work. Verify anchor bolt setting to assure adequate fit of the steel work.
 - 3. For grouting of base plates, see Section 03600.
 - 4. For painting of hot-dipped galvanized elements (duplex system) see Section 09970.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03600, Grout
- B. Section 05500, Miscellaneous Metals

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Federal Specifications:
 - 1. DOD-P-21035 Paint, High Zinc Dust Content, Galvanizing Repair.
 - 2. MIL-P-26915 Primer Coating, Zinc Dust Pigment.
- B. American Institute of Steel Construction (AISC):
 - 1. AISC S302 Code of Standard Practice for Steel Buildings and Bridges.
 - 2. AISC S335 Specification for Structural Steel Buildings Allowable Stress Design and Plastic Design Commentary.
 - 3. AISC M016 Manual of Steel Construction Allowable Stress Design.
- C. ASTM International (ASTM):
 - 1. ASTM A36 Standard Specification for Carbon Structural Steel.
 - 2. ASTM A53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

3. ASTM A123 Standard Specification for Zinc (Hot-Dipped Galvanized) Coatings on Iron and Steel Products.
4. ASTM A153 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
5. ASTM A307 Standard Specification for Carbon Steel Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
6. ASTM A500 Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
7. ASTM A780 Standard Practice for Repair of Damage and Uncoated Areas of Hot-Dipped Galvanized Coating.
8. ASTM A992 Standard Specification for Structural Steel Shapes.
9. ASTM B695 Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.
10. ASTM D6386 Standard Practice for Preparation of Zinc (Hot-Dipped Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting.
11. ASTM F1554 Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.

D. American Welding Society (AWS):

1. AWS A5.1 Specifications for Carbon Steel Electrodes for Shielded Metal Arc Welding.
2. AWS D1.1 Structural Welding Code Steel.

E. Research Council on Structural Connections of the Engineering Foundation (RCSCEF):

1. Specifications for Structural Joints using ASTM A325 or ASTM A490 Bolts.

F. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.4 QUALITY ASSURANCE

A. Identification of Steel:

1. CONTRACTOR shall certify, test, and inspect all materials, welding, fabrication and erection in accordance with the requirements of AISC and AWS D1.1.
2. Submit mill analysis and test reports for the steel, certified by the manufacturer, to show material is in conformance with the specified ASTM standard. CONTRACTOR shall identify steel in accordance with CBC Section 2203 as to heat number and furnish the OWNER's Testing Agency, for their review, mill tests and manufacturer's certification for each heat of steel. Steel that is not readily identifiable as to grade from marking and test records shall be tested to determine conformity to such standards. The cost of such testing shall be paid by the CONTRACTOR.

3. Submit certificates of compliance for welding electrodes indicating material is in conformance with these Specifications.
 4. High strength bolts, nuts, washers and threaded rods shall be sampled and tested in accordance with the requirements of the specification for High Strength Bolts for Structural Steel Joints, ASTM A325 or ASTM A490 Bolts.
- B. Welding Inspection by the OWNER's Testing Agency: All shop and field welding shall be inspected by an AWS certified welding inspector in accordance with AWS D1.1 Section The OWNER's Testing Agency shall provide the following:
1. Review of CONTRACTOR's Welding Procedure Specifications (WPS) submittal and verify that welders are performing work in accordance with the approved WPS.
 2. Verification of welder qualifications.
 3. Verification that electrical meters being used accurately reflect voltage and amperage at the welding site for the length of cable in use.
 4. Visual Inspection: Visually inspect all welding in accordance with AWS D1.1 Section 6, and including verification of fit-up, preheat, calibration of equipment, equipment settings, materials, adherence to approved WPS, interpass temperatures, deposition rates, technique, proper fusion of each pass, ensure the weld is crack free at each pass, confirm porosity and undercut do not exceed AWS requirements, confirm the final weld profile, and confirm that all special requirements specified herein are adhered to.
 5. NDT (non-destructive testing) Ultrasonic Inspection: Test 100% of all complete joint penetration (CJP) groove welds using ultrasonic testing. The ultrasonic instrumentation shall be calibrated by the technician to evaluate the quality of the welds in accordance with AWS D1.1., Section 6.25. Technician who operates the equipment shall examine the welds and maintain a record of all welds examined, defects found and disposition of each defect. All defective welds shall be repaired by the CONTRACTOR and retested with ultrasonic equipment, at the expense of the CONTRACTOR.
 6. NDT (non-destructive testing) Magnetic Particle Inspection: Test 100% of all back-gouged weld roots and 100% of all weld tab removal sites using magnetic particle testing in accordance with ASTM E 709-91. Technician who operates the equipment shall examine the welds and maintain a record of all welds so examined, defects found and disposition of each defect. All defects shall be repaired by the CONTRACTOR and retested at the expense of the CONTRACTOR.
- C. Fabrication and Erection Inspection by the OWNER's Testing Agency: All fabrication and erection of structural steel shall be inspected by the OWNER's Testing Agency. This inspection, in addition to the welding inspection requirements specified herein, shall consist of, but shall not necessarily be limited to, the following:
1. Visually inspect steel shapes and plates for existence of defects such as laminations and non-metallic inclusions. Use ultrasonic equipment and other NDT methods to determine extent of defects.
 2. Verify steel materials with mill certificates. Verify weld filler metal materials with certificates and manufacturers recommended limitations.

3. Review rolled shapes for conformity to dimensional standards specified.
 4. Inspect high strength bolting in conformance with the "Specification for Structural Joints using ASTM A325 or A490 Bolts" as approved by the Research Council on Riveted and Bolted Structural Joints of the Engineering Foundation.
- D. Welding, fabrication and erection Inspection by the OWNER's Testing Agency as required to satisfy the building code requirements for special inspection will be paid for by the OWNER, unless specifically stated otherwise.
1. If inspection of shop fabrication requires the OWNER's Testing Agency to travel further than 100 miles from the project site, the full cost of travel expenses incurred for such inspection shall be covered by the CONTRACTOR.

1.5 SUBMITTALS

- A. Mill Test Reports: CONTRACTOR shall furnish certified copies of all mill analysis and test reports covering the chemical and physical properties of the steel for review by the OWNER's Testing Agency.
- B. Certifications:
1. Certified mill test reports for the structural steel and bolting materials.
 2. Certification that welders are qualified, in accordance with AWS D1.1, on shop and field welding procedures to be used.
- C. Shop Drawings:
1. Detailed shop drawings, erection drawings, schedules, and data for all structural steel. Review will be for general conformance with the Contract Documents and shall not relieve the CONTRACTOR of responsibility for proper fit of members, connections not detailed on the Drawings, or for supplying all material required by the Contract Documents. Mark numbers painted on the shop assembled pieces of steel shall be the same mark numbers used on the detailed shop and erection drawings.
- D. Welding Procedure Specifications (WPS): CONTRACTOR shall submit welding procedure specifications (WPS) and procedure qualification records (PQR) for all welded joint types.
- E. Review of submittals and shop drawings will cover only the general scheme and character of the details, but not the checking of dimensions, nor will such review relieve the CONTRACTOR from responsibility for executing the work in accordance with the Contract Drawings.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials promptly so as to cause no delay with other parts of the Work.
- B. Store materials on skids and not on the ground. Pile and block materials so that they will not become bent or otherwise damaged
- C. Handle materials with cranes or derricks as far as practicable. Do not "dump" steel off cars or trucks, nor handle in any other manner likely to cause damage.

- D. Materials with excessive damage, in the opinion of the ENGINEER, shall not be incorporated into the work. Remove and replace them with new, undamaged materials, at no additional cost to the OWNER.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.
- B. All like materials shall be the products of one manufacturer or supplier in order to provide standardization of appearance.

2.2 MATERIALS

- A. Steel Shapes, Plates and Bars: ASTM A36, typical unless otherwise noted.
- B. Steel Wide-Flange Shapes: ASTM A992.
- C. Steel Tubing: ASTM A500, Grade B.
- D. Steel Pipe: ASTM A53, Type S, Grade B.
- E. Arc-Welding Electrodes: Filler metals shall conform to Table 3.1 of AWS D1.1. Electrodes and equipment settings shall be as recommended by the filler metal manufacturer for the position, thickness or other conditions of actual use. All electrodes and filler metals shall be low hydrogen types. Filler metals with the E70-T4 designation shall not be used.
- F. Anchor Bolts: ASTM F1554 Grade 36.
- G. Machine Bolts: ASTM A307.
- H. High-Strength Bolts: ASTM A325, Connection Type X, N or SC, as indicated on the Drawings.
- I. Shop Primer: As specified in Section 09800.
- J. Galvanizing: Zinc with 0.5 percent (minimum) nickel added.
- K. Galvanized Surface Primer: 95 percent zinc dust, organic vehicle primer.
- L. Duplex System – Galvanizing shall satisfy the requirements of ASTM A123 or A153, as applicable. Water quenching or chromate conversion coating shall be avoided as these processes may interfere with paint adhesion and surface preparation. Refer to Section 09970 for additional information.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

- A. Prepare and shop prime paint non-galvanized members as specified in Section 09800. Do not prime paint faying surfaces of slip critical connections.
- B. Prepare and paint galvanized members as specified in Section 09970.

- C. Galvanize and paint (duplex system) members and their attachments exposed in whole or part to the weather, including beams supporting exterior masonry. Galvanize and paint other members as indicated on the Drawings. Duplex system shall be done after fabrication and in accordance with ASTM A123. Hardware galvanizing shall be in accordance with ASTM A153. Thoroughly clean, pickle, flux, and immerse members in bath of molten zinc until temperature becomes the same as the bath. Coating shall be 2-oz. per-square-foot.
- D. The CONTRACTOR shall notify the OWNER at least four weeks in advance of surface preparation and painting in the fabricator's shop so that a local independent NACE paint inspector can provide local inspection and dry film testing before the steel leaves the shop. The cost for the independent NACE paint inspector will be paid for by the OWNER.

3.2 GENERAL FABRICATION

- A. Workmanship and details of structural steel work, unless otherwise specified, shall conform to the California Building Code and the AISC Specification for Design, Fabrication and Erection of Structural Steel for Buildings. The quality of materials and the fabrication of all welded connections shall conform to the American Welding Society's Structural Welding Code, AWS D1.1.
- B. The CONTRACTOR shall secure all field measurements necessary for the completion of this work. The CONTRACTOR shall be responsible for all errors of detailing and fabrication and for the correct fitting of the structural members to each other and to their supports.
- C. Provide bolts and connections for attachment of the work of other sections to the structural steel. Provide column anchor bolts and templates for setting under Section 03300.
- D. All materials both before and after fabrication shall be protected from corrosion and shall be kept free from dirt, grease and other foreign matter.
- E. Each framing member shall be free from twists and bends. Holes and all cut and sheared edges shall be neatly made without kinks, butts and warped edges. All steel left exposed shall be straight, smooth and free of nicks, scars and dents. Exposed welds shall be uniform and neat.
- F. Holes for Bolts: Holes for bolts shall be 1/16 inch larger than the nominal diameter of the bolt. If the thickness of the material is not greater than the nominal diameter of the bolt plus 1/8 inch, the holes may be punched. Holes in thicker material shall be drilled from the solid or sub-punched and reamed. Holes for high-strength bolts shall have all burrs removed by grinding.
- G. Column Bearing Surfaces: Column bases, as required by the AISC specification, and all column bearing surfaces shall be milled to a true plane perpendicular to the axis of the member to assure a complete bearing at the contact face.

3.3 WELDING

- A. All welding shall be performed in strict adherence with an approved, written WPS.
- B. Preparation for Welding: All surfaces shall be clean, free of rust, paint and foreign matter of any kind. Scale shall be removed by wire brush, chipping or hammering as required. Thermal cut edges to be welded shall be chipped clean, and ground at least 1/32 inch to

bright metal before welding. Clamp members as required, space and alternate welds, all as may be necessary to prevent warping or misalignment.

- C. **Weld Quality:** Welds shall present a uniform surface, free of imperfections as defined by AWS, and without undercutting or over-lapping and free of excessive oxides, gas pockets and non-metallic inclusions. Welds shall be made with the proper number of beads or passes to secure sound, thoroughly fused joints. Each deposit shall not exceed maximum layer height and bead width specified in AWS D1.1. Each pass shall be cleaned by chipping and wire brushing to remove scale and slag, before placing any additional weld metal.
- D. **Sequence of Welding:** For highly restrained connection and/or weldments, the sequence of welding shall be designed to minimize distortion of the members and to minimize the buildup of internal stresses.
- E. **Preheat:** No welding at the joint may proceed, including tack welds, backup bars and weld tabs, until the pre-heating has been completed. Preheat base metals in accordance with AWS D1.1 Table 3.2, except the following minimum values shall apply:
1. For restrained welding conditions, minimum preheat shall be determined using AWS D1.1 Annex XI. Restrained welding conditions shall include but are not limited to: Continuity plates in columns.
 2. For all other welds, minimum preheat shall not be less than as tabulated below:

Minimum Preheat – See Note (2) (ASTM A 36 or ASTM A 572-50 Base Metals)	
Base Metal Thickness	Minimum Preheat
Up to 3/4 Inch	None. See Note (1)
Over 3/4 up to 1-1/2 Inch	75°F
Over 1-1/2 up to 2-1/2 Inch	200°F
Over 2-1/2 up to 3-1/2 Inch	300°F
Over 3-1/2 Inch	350°F min
(1) There should be at least enough heat to drive off any moisture. Comply with AWS D1.1, Table 3.2.	
(2) This table shall not be construed as replacing any more stringent requirements found in AWS D1.1. See also footnote 1 of AWS D1.1, Table 3.2	

- F. **Interpass Temperature:** Minimum interpass temperatures shall be in accordance with the minimum preheat requirements. Maximum interpass temperatures shall not exceed 550°F. Inspector shall measure interpass temperatures during the work. Measurement shall be taken on base metal, not more than 2 inches from the weld.
- G. **Special requirements:**
1. **Technique:** Weld passes shall be made using stringer beads only, weaving passes are not permitted. For multi-pass beam-column flange welds, the first pass shall be placed at the column flange and the welding shall proceed towards the beam flange.

2. Backing Bars: Backing bars, where used, shall be continuous, without butt joints, across the entire width of the joint, including the length of the weld tabs. Unless otherwise noted on the drawings, all backing bars shall be removed by thermal cutting, the root back-gouged, the root and surrounding base metal ground to remove 1/32 inch of surface material, the prepared groove tested for defects using magnetic particle or dye penetrant testing, the groove rewelded and capped with a fillet weld according to the profile indicated on the drawings but not less than 1/4 inch. The weld metal for the backing fillet weld shall be made using the same process and filler metal as the groove weld.
3. Weld Tabs: Weld tabs shall be used for all groove welds, and shall be in accordance with AWS D1.1. Weld tabs shall be removed upon completion of the weld and the ends of the weld shall be made smooth and ground flush with the abutting parts. The detailed transition of weld material to the base metal shall embody a radius not less than the thickness of the beam flange. Except where end of weld is to be NDT tested, grind surface to AWS C4.1-77 Sample 2 roughness, otherwise grind to a smoothness required by the testing technique to be used. "End Dams" or other devices that are placed perpendicular to the weld axis shall not be used.
4. Weld Access Holes: Connection plates at or near the weld access hole shall be sized to ensure the weld access hole region remains unobstructed. Where weld access holes are made by thermal cutting, the surface of the cut and the surrounding base metal shall be ground at least 1/32 inch to bright metal to remove any martensite.
5. Welding through Weld Access Holes: All passes shall begin at the center of the joint and work towards the ends of the joint, terminating on the Weld Tab. Each weld layer shall be completed on both sides of the beam web before the next weld layer is started.
6. Faulty and Defective Welding: Any welding performed without inspection or contrary to the approved WPS, or showing cracks, slag inclusion, lack of fusion, undercut or other defects as defined by AWS, ascertained by visual or other means of inspection, shall be chipped out and properly replaced by the CONTRACTOR, and reinspected by OWNER's Testing Agency, at the CONTRACTOR's expense.

3.4 ERECTION

- A. Field Connections: Workmanship of field bolted and welded connections shall conform in all respects to methods and tolerances specified for fabrication.
- B. High strength bolted connections shall be made in conformance with the "Specification for Structural Joints using ASTM A325 or A490 Bolts" approved by Research Council on Riveted and Bolted Joints of the Engineering Foundation.
- C. Furnish and install temporary bracing to provide stability during erection and to prevent distortion or damage to the framing due to wind, seismic, or erection forces. Remove temporary bracing when erection is complete.
- D. No final connections shall be made until the structure has been properly aligned. All temporary flooring, planking and scaffolding necessary in connection with the erection of the structural steel, or the support of erection machinery shall be provided as part of the

erection work. The temporary floors and scaffolding shall conform to the requirements of all laws governing safety regulations.

- E. Drifting done during assembly shall not distort the metal or enlarge the holes. Mismatching of holes greater than 3/32 inch shall require reaming for the next larger bolt. Mismatching of holes greater than 1/8 inch shall be cause for rejection.

3.5 DEFECTIVE WORK

- A. Work found to be defective, missing or damaged shall immediately be replaced with proper work. Such replaced work and the inspection for same shall be at the expense of the CONTRACTOR.
- B. Straightening of any material, if necessary, shall be done by a process and in a manner that will not injure the materials, and which is approved by the ENGINEER. Sharp kinks or bends shall be cause for rejection. Heating will not be allowed.
- C. Delamination and other rolling defects in structural shapes and plates shall be cause for rejection when, in the judgment of the ENGINEER, repairs are not feasible or acceptable.
- D. If defects or damaged work cannot be corrected in the field, the material shall be returned to the shop or new parts furnished, as the ENGINEER directs; the CONTRACTOR shall replace all work at his own expense.

END OF SECTION

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SECTION 05500– MISCELLANEOUS METALS

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. Furnish all labor, materials, equipment and incidentals required and install all miscellaneous metal complete as shown on the Drawings and as specified herein.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03100, Concrete Formwork
- B. Section 03150, Concrete Joints and Joint Accessories
- C. Section 03200, Concrete Reinforcement
- D. Section 03300, Cast-in-Place Concrete
- E. Section 03600, Grout

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Federal Specifications:

- 1. DOD-P-21035 – Paint, High Zinc Dust Content, Galvanizing Repair
- 2. FF-B-575C - Bolts, Hexagonal and Square.
- 3. MIL-G-18015 A (3) - (Ships) Aluminum Planks (6063-T6)
- 4. MIL-A-907E - Antiseize Thread Compound, High Temperature.
- 5. MIL-P-26915 – Primer Coating, Zinc Dust Pigment

B. Aluminum Association:

- 1. AA-M32C22A41 - M31 – Mechanical Finish, Fine Satin; C22 – Finish, Medium Matte; A41 – Clear Anodic Coating, Class I

C. American Association of State Highway and Transportation Officials (AASHTO):

- 1. Standard Specifications for Highway Bridges – HS20 Truck Loading

D. American Concrete Institute (ACI):

- 1. ACI 355.2 - Qualification of Post-Installed Mechanical Anchors in Concrete.
- 2. ACI 355.4 - Qualification of Post-Installed Adhesive Anchors in Concrete

E. American Institute of Steel Construction:

- 1. Steel Construction Manual

F. American Iron and Steel Institute (AISI):

1. Design of Light Gauge, Cold-Formed Steel Structural Members

G. ASTM International (ASTM):

1. ASTM A36 - Standard Specification for Carbon Structural Steel
2. ASTM A48 - Standard Specification for Gray Iron Castings
3. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
4. ASTM A108 - Standard Specification for Steel Bar, Carbon and Alloy, Cold Finished.
5. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
6. ASTM A125 - Standard Specification Steel Springs, Helical, Heat Treated.
7. ASTM A153 - Standard Specification Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
8. ASTM A167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip.
9. ASTM A193 - Standard Specification for Alloy Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and other Special Purpose Applications.
10. ASTM A194 - Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
11. ASTM A276 - Standard Specification for Stainless Steel Bars and Shapes.
12. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
13. ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 KSI Minimum Tensile Strength.
14. ASTM A384 Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies.
15. ASTM A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
16. ASTM A501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
17. ASTM A536 - Standard Specification for Ductile Iron Castings.
18. ASTM A563 - Standard Specification for Carbon and Alloy Steel Nuts.

19. ASTM A575 - Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades.
20. ASTM A780 – Standard Practice for Repair of Damage and Uncoated Areas of Hot-Dipped Galvanized Coatings.
21. ASTM A786 - Standard Specification for Hot-Rolled Carbon, Low Alloy, High Strength Low Alloy and Alloy Steel Floor Plates.
22. ASTM A992 – Standard Specification for Structural Steel Shapes
23. ASTM A1008 - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High Strength Low Alloy, High Strength Low Alloy with Improved Formability, Solution Hardened, Bake Hardenable.
24. ASTM A1011 - Standard Specification for Steel, Sheet and Strip, Hot-Rolled Carbon, Structural, High Strength Low Alloy and Ultra-High Strength, and High Strength Low Alloy with Improved Formability
25. ASTM B98 - Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.
26. ASTM B201 – Standard Practice for Testing Chromate Coatings on Zinc and Cadmium Surfaces.
27. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
28. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles and Tubes.
29. ASTM B429 - Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
30. ASTM B695 - Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.
31. ASTM C633 – Standard Test Method for Adhesion or Cohesion Strength of Thermal Spray Coatings.
32. ASTM D6386 – Standard Practice for Preparation of Zinc (Hot-Dipped Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting.
33. ASTM E140 – Hardness Conversion Tables for Metals
34. ASTM E376 Standard Practice for Measuring Coat Thicknesses by Magnetic- Field or Eddy-Current (Electromagnetic) Examination Methods.
35. ASTM E384 – Micro Hardness of Materials
36. ASTM F593 – Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
37. ASTM F594 – Standard Specification for Stainless Steel Nuts

38. ASTM F1554 – Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

H. American Welding Society (AWS)

1. ANSI/AWS D1.1- Structural Welding Code – Steel.
2. ANSI/AWS D1.2 - Structural Welding Code – Aluminum.
3. ANSI/AWS QC1 - Qualification and Certification of Welding Inspectors.

I. National Fire Protection Association (NAFP):

1. NFPA 101 - Life Safety Code.

J. National Association of Architectural Metal Manufacturers (NAAMM)

1. Metal Stairs Manual.

K. National Association of Corrosion Engineers (NACE)

1. Coating Inspector Program (CIP)

L. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.4 SUBMITTALS

A. Shop Drawings - Shop drawings of all miscellaneous metalwork shall be submitted to the ENGINEER for review in accordance with Division 1.

B. Layout drawings for grating and/or aluminum plank grating shall be submitted showing the direction of span, type and depth, size and shape of panels, seat angle details, and details of hold down fasteners. Load and deflection tables shall be submitted for each style and depth of grating/plank grating used.

C. Manufacturer's shop drawings for Pre- Engineered Structure (Canopy), showing dimensions, materials lists, methods of supporting, methods of anchoring, and finishes. Shop drawings shall include, as a minimum, plans elevations, sections, details of components and attachments to other units of the Work.

D. Welding Procedure Specifications (WPS): Contractor shall submit Welding Procedure Specifications (WPS) and Procedure Qualification Records (PQR) for all welding joint types, as applicable.

E. An ICC-ES report listing the ultimate load capacity in tension and shear for each size and type of post installed concrete anchor used shall be submitted to the ENGINEER for review. CONTRACTOR shall submit manufacturer's recommended installation instructions and procedures for all mechanical and adhesive anchors for ENGINEER's review. Upon review, by ENGINEER, these instructions shall be followed explicitly.

F. No substitution for the indicated mechanical and/or adhesive anchors will be considered unless accompanied with ICC-ES report verifying strength and material equivalency, including temperature at which load capacity is reduced to 90 percent of that determined at 75 degrees F.

G. Samples:

1. Submit 12-in-by-12-in samples of metal grating, aluminum plank grating and cover plates, illustrating surface finish, color, texture and jointing details.
2. Submit 12-in long samples of guardrail and handrail. Submit samples of elbow, tee, wall bracket, escutcheon, end stop and rail joint connections.
3. Pre-Engineered Structure (Canopy) – Samples for verification of each type of exposed finish required, prepared in components of the same thickness and metal indicated for the final Work. Where finishes involve normal color and texture variations, include sample sets showing the full range of variations expected.

H. Design Data:

1. Submit calculations or test data demonstrating that the railings will resist the loads specified in the California Building Code at the post spacing provided.
2. Submit manufacturer's load and deflection tables for grating, and aluminum plank grating.
3. Pre-Engineered Structures:
 - a. Submit design calculations, signed and sealed by a Civil or Structural Engineer, licensed within the State of California for the pre-engineered structure (Canopy).
 - b. Submit data showing the location, magnitude, and direction of all dead, live, wind, and seismic load reactions imposed on the structure(s) by the pre-engineered structure (canopy).

I. Test Reports:

1. Certified copy of mill test reports on each steel and aluminum proposed for use showing the physical properties and chemical analysis.

J. Certificates:

1. Submit certification that the railing system is in compliance with OSHA requirements and California Building Code.
2. Submit Manufacturer's certification that pre-engineered structure (Canopy) materials meet Contract Document requirements.
3. Submit coating applicator's Certificate of Compliance that the prepared hot-dipped galvanized coating surface meets or exceeds the requirements for successful painting of the surface.

1.5 QUALITY ASSURANCE

- A. The work of this Section shall be completely coordinated with the work of other Sections. Verify, at the site, both the dimensions and work of other trades adjoining items of work in this Section before fabrication and installation of items herein specified.

- B. Furnish to the pertinent trades all items included under this Section that are to be built into the work of other Sections.
- C. All welding shall be performed by qualified welders and shall conform to the applicable AWS welding code. Welding of steel shall conform to AWS D1.1 and welding of aluminum shall conform to AWS D1.2.
- D. All welding procedures and welder qualification shall be available at the place of manufacture and in the CONTRACTOR's field office for ENGINEER's review.
- E. All welding shall be inspected by an OWNER provided inspector qualified in accordance with AWS requirements and approved by the ENGINEER.
- F. Unless otherwise directed by the ENGINEER, the CONTRACTOR shall provide the services of an independent NACE certified coating inspector. The cost of such work, except as specifically stated otherwise, shall be paid by the CONTRACTOR. All shop applied coatings shall be inspected by an inspector, qualified in accordance with NACE requirements and approved by the ENGINEER.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver items to be incorporated into the work of other trades in sufficient time to be checked prior to installation.
- B. Items damaged during transit, inadequate storage, improper handling, or corroded, in the opinion of the ENGINEER, shall be repaired, at the CONTRACTOR's expense, to the satisfaction of the ENGINEER prior to incorporating them into the work.

1.7 PROJECT/SITE REQUIREMENTS

- A. Field measurements shall be taken at the site, prior to fabrication of items, to verify or supplement indicated dimensions and to ensure proper fitting of all items.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. The use of manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.
- B. Like items of materials shall be the end products of one manufacturer in order to provide standardization for appearance, maintenance and manufacturer's service.
- C. Steel – Unless otherwise noted:
 - 1. Shapes, Plates, Bars: ASTM A36, unless otherwise noted.
 - 2. Wide-flange structural steel shapes: ASTM A992.
 - 3. Pipe, Pipe Columns, Bollards: ASTM A53, Type E or S, Grade B Standard weight unless noted otherwise.
 - 4. Tubes: ASTM A500 Grade B.

5. Corrosion Protection - Unless otherwise indicated, miscellaneous metalwork of fabricated steel, which will be used in a corrosive environment and/or will be submerged in water/wastewater shall be coated in accordance with Section 09800 – Protective Coating. All other miscellaneous steel metalwork shall be hot-dip galvanized after fabrication as specified herein.
- D. Stainless Steel – Unless otherwise noted:
1. Exterior - Stainless steel plates, sheets, and structural shapes ASTM A167, Type 316 (Type 316L for welding) stainless steel and shall not be galvanized. Where anaerobic conditions are noted, Type 304 stainless steel shall be used.
 2. Interior/Architectural - Stainless steel plates, sheets, and structural shapes ASTM A167, Type 316.
- E. Aluminum – Unless otherwise noted:
1. Extruded Pipe ASTM B429, Alloy 6063-T6.
 2. Extruded Shapes ASTM B221, Alloy 6061-T6.
 3. Sheet and Plate ASTM B209, Alloy 6061-T6.
 4. Aluminum in contact with concrete, masonry, wood, porous materials, or dissimilar metals shall have contact surfaces coated in accordance with the Section 09800 – Protective Coating.
- F. Cast Iron – Unless otherwise noted:
1. Iron castings shall conform to the requirements of ASTM A48, Class 50B or better.
- G. Bolts, Nuts, and Washers – Unless otherwise noted:
1. Carbon Steel Bolts and Studs ASTM A307, Grade A (hot dip galvanized nuts and washers where noted).
 2. Carbon Steel Anchor Bolts for building anchorage ASTM F1554 Grade 36, unless otherwise noted (hot dip galvanized nuts and washers where noted).
 3. Stainless Steel Bolts, Nuts, and Washers, ASTM F593 and ASTM F594, Type 316.
 4. High Strength Steel Bolts, Nuts, and Washers ASTM A325 (mechanically galvanized per ASTM B695, Class 50, where noted).
 - a. Elevated Temperature Exposure Type I.
 - b. General application Type I or Type II
- H. Galvanizing – ASTM A123, Zn with 0.5 percent minimum Ni.
- I. Galvanizing – Hardware ASTM A153, Zn with 0.5 percent minimum Ni.
- J. Duplex System – Galvanizing shall satisfy the requirements of ASTM A123 or A153, as applicable. Water quenching or chromate conversion coating shall be avoided as these processes may interfere with paint adhesion and surface preparation.

2.2 MISCELLANEOUS ALUMINUM

- A. All miscellaneous metal work shall be formed true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture and free from defects impairing strength or durability. Holes shall be drilled or punched. Edges shall be smooth and without burrs. Fabricate supplementary pieces necessary to complete each item though such pieces are not definitively shown or specified.
- B. Connections and accessories shall be of sufficient strength to safely withstand the stresses and strains to which they will be subjected. Exposed joints shall be close fitting and jointed where least conspicuous. Threaded connections shall have the threads concealed where practical. Welded connections shall have continuous welds or intermittent welds as specified or shown. The face of welds shall be dressed flush and smooth. Welding shall be on the unexposed side as much as possible in order to prevent pitting or discoloration of the aluminum-exposed surface. Provide holes for temporary field connections and for attachment of the work of other trades.
- C. Miscellaneous aluminum items shall include: beams, angles, closure angles, grates, hatches, floor plates, stop plates, stair nosing, and any other miscellaneous aluminum called for on the Drawings and not otherwise specified.
- D. Angle frames for hatches, beams, grates, etc, shall be complete with welded strap anchors attached.
- E. Stair treads for aluminum stairs shall have abrasive non-slip nosing as approved.
- F. Aluminum nosing at concrete stairs shall be Alumogrit Treads, Type 116, by Wooster Products, Inc.; similar by Barry Pattern and Foundry Co.; or approved equal. Furnish with wing type anchors and flat head stainless steel machine screws, 12-in on center. Nosing shall also be used at concrete ladder openings. Nosing shall be a single piece for each step extending to within 3-in at each side of stair or full ladder width. Set nosing flush with stair treads finish at concrete stairs. Furnish treads with heavy-duty protective tape cover.

2.3 MISCELLANEOUS STEEL

- A. All miscellaneous metal work shall be formed true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture and free from defects impairing strength or durability. Holes shall be drilled or punched. Edges shall be smooth and without burrs. Fabricate supplementary pieces necessary to complete each item though such pieces are not definitively shown or specified.
- B. Connections and accessories shall be of sufficient strength to safely withstand the stresses and strains to which they will be subjected. Exposed joints shall be close fitting and jointed where least conspicuous. Threaded connections shall have the threads concealed where practical. Welded connections shall have continuous welds or intermittent welds as specified or shown. The face of welds shall be dressed flush and smooth. Provide holes for temporary field connections and for attachment of the work of other trades.
- C. Miscellaneous steel items shall include: beams, angles, lintels, metal stairs, support brackets, base plates for other than structural steel or equipment, closure angles, bridge crane rails, monorail hoist beams, hold down straps and lugs, door frames, splice plates, sub framing at roof openings and any other miscellaneous steel called for on the Drawings and not otherwise specified.

- D. Steel pipe pieces for sleeves, lifting attachments and other functions shall be Schedule 40 pipe unless otherwise shown on the Drawings. Wall and floor sleeves, of steel pipe, shall have welded circumferential steel waterstops at mid-length.
- E. All steel finish work shall be thoroughly cleaned, by effective means, of all loose mill scale, rust and foreign matter and shall be given one shop coat of primer compatible with the finish coat after fabrication but before shipment. Paint shall be omitted within 3- in of proposed field welds. Paint shall be applied to dry surfaces and shall be thoroughly and evenly spread and well worked into joints and other open spaces.
- F. Galvanizing, where required, shall be the hot-dip zinc process after fabrication. Coating shall be not less than 2 oz/sq ft of surface.

2.4 MISCELLANEOUS STAINLESS STEEL

- A. All miscellaneous metal work shall be formed true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture and free from defects impairing strength or durability. Holes shall be drilled or punched. Edges shall be smooth and without burrs. Fabricate supplementary pieces necessary to complete each item though such pieces are not definitively shown or specified.
- B. Connections and accessories shall be of sufficient strength to safely withstand the stresses and strains to which they will be subjected. Exposed joints shall be close fitting and jointed where least conspicuous. Threaded connections shall have the threads concealed where practical. Welded connections shall have continuous welds or intermittent welds as specified or shown. The face of welds shall be dressed flush and smooth. Provide holes for temporary field connections and for attachment of the work of other trades.
- C. Miscellaneous stainless steel items shall include: beams, angles, bar racks and any other miscellaneous stainless steel called for on the Drawings and not otherwise specified.

2.5 MISCELLANEOUS FRAMING AND SUPPORTS

- A. Provide miscellaneous metal framing, supports, and other metal items required, including framing for architectural infill panels, which are not a part of the structural steel framework but are required to complete the work.
- B. Fabricate miscellaneous units to the sizes, shapes, and profiles shown or, if not shown, of the required dimensions to receive adjacent grating, plates, tanks, doors, or other work to be retained by the framing. Except as otherwise shown, fabricate from structural shapes, plates, and bars, of all welded construction using mitered corners, welded brackets and splice plates and a minimum number of joints for field connection. Cut, drill, and tap units to receive hardware and similar items to be anchored to the Work.
- C. Equip units with integrally welded anchors for casting into concrete. Furnished inserts for units must be installed after concrete is placed.
- D. Except as otherwise shown, space anchors, 24-inches on center, and provide units equivalent of 1¼-inch by 1¼-inch by 8-inch strips.
- E. Galvanize all miscellaneous framing and supports.

2.6 FRAMING SUPPORT SYSTEMS FOR PIPE ASSEMBLIES, ANALYZERS AND APPURTENANCES

- A. Provide framing support systems for pipe assemblies shown on the Contract Drawings.
- B. Furnish and install all anchoring and connecting hardware required for assembly and installation of the framing support system(s).
- C. All anchoring and connecting hardware shall be Type 316 Stainless Steel.
- D. All exterior framing support systems, and all systems within sub grade vaults, for pipe assemblies and appurtenances shall be fabricated of Type 316 Stainless Steel.
- E. All framing support systems that are used in interior, non-submerged applications shall be fabricated of low carbon steel and furnished with a factory-applied, hot-dipped, galvanized coating.
- F. Where framing support systems are shown in locations with no adjacent wall, the framing support system shall be free-standing and designed to withstand a point load of 200-pounds applied at the top of the framing system such that the maximum deflection shall not exceed ¼-inch. Base support members shall be a minimum of 2-feet long and shall use Unistrut P2348 connectors, or approved equal.
- G. Manufacturer – Unless otherwise shown, all members shall be P1000, manufactured by Unistrut, or approved equal, with type "HS" hole pattern.

2.7 PRE-ENGINEERED STRUCTURE (CANOPY)

- A. The pre-engineered structure shall be Navajo Shelter, as manufactured by Americana Building Products, Hip Shelter, as manufactured by Icon Shelter Systems, Inc., or approved equal. Pre-Engineered Structure (Canopy)
- B. Roof Panels – Structural panels shall be roll-formed stucco embossed aluminum with a watertight snap lock connection. Panels shall be 2½-inches in depth and provided a net coverage of 24-inches. Panels shall be constructed from aluminum alloy 300-H154. The panel shall be coated with the finest thermosetting acrylic finish, color to match other site structures or as selected by the OWNER.
- C. Column and Rafters – Structural columns and rafters shall be constructed from square hollow structural sections, 6-inch minimum dimension. The steel shall conform to ASTM A500 with minimum of 46,000 psi yield strength and 58,000 psi tensile strength.
- D. Plates – Column base-plates, butt-plates, and diagonal bracing shall be constructed from steel plate conforming to ASTM A36.
- E. Gutter, Fascia, and Trim – Aluminum gutter, fascia, and trim shall be provided. Components shall be constructed from aluminum alloy 6063-T5 or 6105-T5.
- F. Fasteners – Structural steel bolts shall meet the requirements of ASTM A325 or A307. Roof panels to structural steel, at a minimum, #12x¾" #3 TEK zinc plated hex head and neoprene washer, or approved equal. Gutter or fascia to roof panels, at a minimum, #8-18x¾" #2 TEK 410SS, or approved equal. Sheet metal screws shall be either cadmium or zinc-plated.
- G. Welding – All welding shall comply with AWS D5.1 or AWS D5.5, E70XX Electrodes.

- H. Protective Coating – All steel finish work shall receive a shop applied polyamide epoxy primer over galvanized steel elements in accordance with Section 09970 – Shop Painting of Hot – Dipped Galvanized Steel.

2.8 METAL GRATING

- A. General: Metal grating shall be of the design, sizes and types indicated. Grating shall be completely banded at all edges and cutouts using material and cross section equivalent to the bearing bars. Such banding shall be welded to each cut bearing bar. Support members shall support grating on all sides of an opening. Where grating is supported on concrete, embedded support angles matching grating material shall be used on all sides, unless shown otherwise. Such angles shall be mitered and welded at corners.
- B. All pieces of grating shall be securely fastened in two locations to each support. Grating clips, fasteners, anchors, bolts, nuts, and washers for grating and supports shall be Type 316 Stainless Steel.
- C. Where grating forms the landing at the top of a stairway, the edge of the grating, which forms the top riser, shall have an integral non-slip nosing, width equal to that of the stairway.
- D. Where grating depth is not given, grating shall be provided which will be within allowable stress levels, and which shall not exceed a deflection of 1/4 inch or the span divided by 180, whichever is less. For standard duty, plank, and safety grating, the loading to be used for determining stresses and deflections shall be the uniform live load of the adjacent floor or 100-psf, whichever is greater or a concentrated load of 1000 pounds. For heavy duty grating, the loading used for determining stresses and deflections shall be AASHTO HL-93 (HS20).
- E. At a minimum, grating bars shall be I-bar configuration and be spaced at 1-3/16-inches on center. Crossbars shall be spaced at 4-inches on center, unless otherwise noted.
- F. Grating cross bars shall be attached to the bearing bars with interlocked swaged joints having no exposed welding.
- G. Openings 2-inch or greater in diameter/dimension and grating edges shall be banded with a bar of the same depth and thickness as the bearing bars. Cut bearing or cross bars shall be welded to the banding bar.
- H. Unless otherwise designated by the ENGINEER, the maximum weight of each grating section shall be 80-pounds.
- I. Material:
 - 1. Except where indicated otherwise, bar grating shall be fabricated entirely of aluminum, Alloy 6063-T6.
 - 2. Grating which may be partially or wholly submerged shall be fabricated entirely of stainless steel, Type 316.
 - 3. Grating frames, anchors, and supports shall be all aluminum construction, fabricated from aluminum alloy 6061-T6 or as specified on the drawings.
- J. Standard Duty Grating:

1. No single piece of grating shall weigh more than 80 pounds, unless indicated otherwise. Standard duty grating shall be serrated bar grating.
2. Crossbars shall be welded or mechanically locked tightly into position so that there is no movement allowed between bearing and cross bars.

K. Safety Grating:

1. Safety grating shall be made of sheet metal punched into an open serrated diamond pattern and formed into plank sections. The open diamond shapes shall be approximately 1-7/8 inch by 11/16 inch in size. Safety grating shall be Grip Strut by G.S. Metals; Safe-T-Grid by IKG Industries, or approved equal.

2.9 ALUMINUM PLANK GRATING

- A. General: Aluminum Plank Grating (plank) shall be of the design, sizes and types indicated within the Drawings or specified herein. Support members shall support plank on all sides of an opening. Where plank is supported on concrete, embedded support angles matching plank material shall be used on all sides, unless shown otherwise. Such angles shall be mitered and welded at corners.
- B. Unless otherwise noted, punched plank shall consist of 3"x19/32" rectangular openings, 1½-inch center-to-center and with raised transverse ribs for stiffness.
- C. Planks shall be provided with a skid resistance surface, SlipNot® (or approved equal) surface treatment applied for added slip resistance.
- D. Unpunched plank shall be provided with recessed lift handles.
- E. All pieces of plank shall be securely fastened in two locations to each support. Tread plate, fasteners, anchors, bolts, nuts and washers for supports shall be Type 316 Stainless Steel.
- F. Where plank depth is not given, tread plate shall be provided which will be within allowable stress levels, and which shall not exceed a deflection of ¼ inch or the span divided by 180, whichever is less. For standard duty, tread plate, shall be the uniform live load of the adjacent floor or 100-psf, whichever is greater or a concentrated load of 1000 pounds.
- G. Unless otherwise designated by the ENGINEER, the maximum weight of each plank grating shall be 80-pounds.
- H. Material:
 1. Except where indicated otherwise, plank shall be fabricated entirely of aluminum, Alloy 6063-T6.
 2. Plank that may be partially or wholly submerged shall be fabricated entirely of stainless steel, Type 316.
 3. Plank frames, anchors, and supports shall be all aluminum construction, fabricated from aluminum alloy 6063-T6 or as specified on the Drawings.
- I. Heavy Duty Plank Grating:

1. Unless otherwise designated by the ENGINEER, no single piece of plank shall weigh more than 80 pounds. Heavy duty plank shall be fabricated by Ohio Gratings, Incorporated, Seidelhuber Metal Products, IKG, or approved equal.

2.10 CHECKERED PLATE

- A. Checkered plate shall be not less than 1/4-inch thick (3/8-inch plate thickness for aluminum), and shall have a pattern of raised lugs on one face and shall be smooth on the opposite face. Lugs shall be a minimum of one inch in length and raised a minimum of 0.050 inch above the surface. The lugs shall be located in a pattern in which the lugs are oriented at 90 degrees from the adjacent lugs in two orthogonal directions. The rows of lugs shall be oriented at 45 degrees from the edges of the plates.
- B. Where no plate material is indicated on the drawings, aluminum alloy 6061-T6 shall be provided. Unless noted otherwise on the drawings, the minimum plate thickness shall be as required to limit deflection, resulting from the greater of the uniform live load of the adjacent floor or a live load of 100 psf, to 1/4-inch or the span divided by 240, whichever is less.
- C. Cover plate fastening devices and hardware shall be Type 316 Stainless Steel.
- D. Mill Finish.

2.11 FLOOR HATCHES

- A. Where access hatches are called for on the drawings to be mounted on a floor slab (including top slabs which are not covered with a roofing membrane) or on a concrete curb, the hatch shall be a flush type as indicated herein.
- B. All hatches shall be fabricated from Aluminum 6061-T6 unless otherwise indicated. All hatch hardware shall be Type 316 stainless steel. Hatches shall be gutter-type; Bilco Type "J" or "JD"; Babcock-Davis type "B-FGA" or approved equal, or as shown.
- C. Design Live Loads:
 1. Where located within a structure, the design loading shall match that required for the adjacent floor area, or, if no loading is given, a minimum of 300 pounds per square foot, unless indicated otherwise.
 2. Exterior covers and grates shall be designed for AASHTO HL-93 (HS20) loading unless indicated otherwise.
- D. Hatch Opening:
 1. Sizes, number and direction of swing of door leaves, and locations, shall be as indicated on the Drawings. Sizes given shall be for the clear opening. Where the number of leaves is not given, openings larger than 42 inches in either direction shall have double-leaf doors.
 2. Unless indicated otherwise, hinges shall be located on the longer dimension side.
 3. Unless indicated otherwise, ladder hatches shall be a minimum of 30 inches wide by 36 inches long, with the ladder centered on the shorter dimension, and the door hinge opposite the ladder.

4. Door leaves shall be a minimum of 1/4-inch checkered pattern plate. Channel frames shall be a minimum of 1/4-inch material with an anchor flange around the perimeter.
5. Hatches shall be provided with an automatic hold-open arm with release handle. Hatches shall be designed for easy opening by one person from both inside and outside and shall be balanced to require no more than 30 pounds of opening force (lift-assist). Compression spring operators enclosed in telescoping tubes shall be provided for smooth, easy and controlled door operation throughout the entire arc of opening and closing.
6. Hatches shall be designed to be watertight and shall be equipped with a joint gutter and moat-type edge drain. A 1½-inch diameter (minimum) drain connection shall be provided and located by the manufacturer.
7. Hatches shall include a recessed hasp for a padlock that is covered by a hinged lid flush with the surface.

2.12 IRON CASTINGS

- A. Iron castings shall be of uniform quality, free from blowholes, porosity, hard spots, shrinkage, distortion, or other defects. They shall be smooth and well cleaned by shot blasting.
- B. Covers and grates shall fit together evenly, so that the cover fits flush with the surrounding finish surface and so that the cover does not rock or rattle when loading is applied. Round covers and frames shall have machined bearing surfaces.
- C. Covers and grates with matching frames shall be designed to support the following loadings:
 1. Where located within a structure, the design loading shall match that required for the adjacent floor area, or, if no loading is given, a minimum of 300 pounds per square foot, unless indicated otherwise.
 2. Exterior covers and grates shall be designed for AASHTO HL-93 (HS20) loading unless indicated otherwise.

2.13 STEEL PROTECTION POSTS (BOLLARDS)

- A. Provide 4-inch diameter, Schedule 40 steel pipe, 4'-0" above grade, 3'-6" below grade.

2.14 FALL PREVENTION SYSTEM

- A. The fall prevention system shall be the RTC-2000 Climb Rite, as manufactured by Sellstrom; Saf-T-Climb, as manufactured by North Products, Inc., or approved equal. All necessary components shall be provided, including two safety belts for each fall prevention installation to provide a complete and fully operational fall prevention system. A rail extension shall be provided for each installation. At all locations where fall prevention systems are installed, a safety chain with a snap hook shall be permanently attached to the top of the ladder. The chain shall be long enough to allow a person to connect the belt to the chain while standing on the landing adjacent to the ladder. The chain and snap hook shall have a minimum allowable capacity of 500 pounds. Safety belts shall fit a waist range from 23 inches to 54 inches. Safety rails and associated

accessories shall match the ladder material. Fiberglass ladders shall have stainless steel safety rails and accessories

2.15 BOLTS AND ANCHORS

- A. Standard Service (Non-Corrosive Application): Unless otherwise indicated, bolts, anchor bolts, washers, and nuts shall be steel, galvanized after fabrication as indicated herein. Threads on galvanized bolts and nuts shall be formed with suitable taps and dies such that they retain their normal clearance after hot-dip galvanizing. Except as otherwise indicated, steel for bolts, anchor bolts and cap screws shall be in accordance with the requirements of ASTM A307, Grade A.
- B. Corrosive Service: All bolts, nuts, and washers in the locations listed below shall be stainless steel as indicated below.
 - 1. All buried locations.
 - 2. All submerged locations.
 - 3. All locations subject to seasonal or occasional flooding.
 - 4. Inside hydraulic structures below the top of the structure.
 - 5. Inside buried vaults, manholes, and structures that do not drain through a gravity sewer or to a sump with a pump.
 - 6. All chemical handling areas.
 - 7. Inside trenches, containment walls, and curbed areas.
 - 8. Locations indicated on the Contract Documents or designated by the ENGINEER to be provided with stainless steel bolts.
- C. All bolted connections for aluminum members shall be stainless steel.
- D. Unless otherwise indicated, stainless steel bolts, anchor bolts, nuts, and washers shall be Type 316 stainless steel, class 2, conforming to ASTM A276. All threads on stainless steel bolts shall be protected with an antiseize lubricant suitable for submerged stainless steel bolts, to meet government specification MIL-A-907E. Buried bolts in poorly drained soil shall be coated the same as the buried pipe.
 - 1. Antiseize lubricant shall be classified as acceptable for potable water use by the NSF.
 - 2. Antiseize lubricant shall be "PURE WHITE" by Anti-Seize Technology, Franklin Park, IL; or approved equal.
- E. Bolt Requirements:
 - 1. The bolt and nut material shall be free-cutting steel.
 - 2. The nuts shall be capable of developing the full strength of the bolts. Threads shall be Coarse Thread Series conforming to the requirements of the American Standard for Screw Threads. All bolts and cap screws shall have hexagon heads and nuts shall be Heavy Hexagon Series.

3. All bolts and nuts shall be installed with washers fabricated of material matching the base material of bolts, except that hardened washers for high strength bolts shall conform to the requirements of the AISC Specification. Lock washers shall be installed with washers where indicated and shall be fabricated of material matching the bolts.
4. The length of all bolts shall be such that after joints are made up, each bolt shall extend through the entire nut, but in no case more than 1/2-inch beyond the nut.

F. Cast-in-Place Anchor Bolts – Unless otherwise indicated, the embedded end of the anchor bolt shall be either headed or with nut and washer. Threaded dimensions for cast-in headed studs and/or headed bolts, prior to zinc coating, shall conform to the requirements of ANSI/ASME B1.1 having Class 2A tolerances (ANSI/ASME Standard B1.13M Grade 6g). Use of hooked bolts (J-bolts and L-bolts) in lieu of headed studs/bolts is not permissible.

1. Equipment subject to vibration e.g., pumps, motors, generators, etc. shall be anchored by means of cast-in-place anchor bolts. Anchor bolt layout shall be by means of a template obtained from the equipment manufacturer or supplier.

G. Adhesive Anchors - Unless otherwise indicated, all adhesive anchors for installation in concrete shall have satisfied the requirements of the Simulated Seismic Tests of ACI 355.4. No substitutions will be considered unless accompanied with ICC-ES report verifying strength and material equivalency and compliance with ACI 355.4.

1. Adhesive anchors shall be Hilti HIT-RE 500-SD adhesive anchors (Hilti HIT-HY 150-SD if exposed to influent), Simpson SET-XP epoxy adhesive anchors, or approved equal.
2. Adhesive anchors shall not be used for overhead installations (i.e. installations at the underside of concrete slabs).

H. Expansion (Wedge) Anchors – Unless otherwise indicated all expansion anchors for installation in concrete shall have satisfied the requirements of the Simulated Seismic Tests of ACI 355.2. Expansion Anchors shall be zinc plated carbon steel wedge type anchors complete with nuts and washers. Type 316 stainless steel, wedge type anchors shall be used where they will be submerged or exposed to the weather or where stainless steel wedge type anchors are required. When the length or embedment of the bolt is not noted on the Drawings, provide length sufficient to place the wedge and expansion sleeve portion of the bolt at least 1-inch behind the concrete reinforcing steel.

1. Expansion anchors shall be Hilti Kwik Bolt TZ anchors, Simpson Strong-Bolt Wedge anchors, or approved equal.
2. Shell and Lead caulking anchors will not be permitted.
3. Post installed concrete anchors (mechanical and adhesive), shall not be used with equipment subject to vibration e.g., pumps, motors, etc.

2.16 POWDER DRIVEN PINS (PDA)

A. Powder-driven pins for installation in concrete or steel shall be heat-treated steel alloy. If the pins are not inherently sufficiently corrosion-resistant for the conditions to which they are to be exposed, they shall be protected in an acceptable manner. Pins shall have capped or threaded heads capable of transmitting the loads the shanks are required to

support. Pins that are connected to steel shall have longitudinal serrations around the circumference of the shank.

2.17 IMPACT ANCHOR

- A. Impact anchors shall be an expansion type anchor in which a nail type pin is driven to produce the expansive force. It shall have a zinc sleeve with a mushroom style head and stainless steel nail pin. Anchors shall be Metal Hit Anchors, manufactured by Hilti, Inc., Zamac Nailin, manufactured by the Powers Fasteners; or approved equal.

PART 3 EXECUTION

3.1 FABRICATION AND INSTALLATION REQUIREMENTS

- A. Fabrication and Erection: Except as otherwise indicated, the fabrication and erection of structural steel shall conform to the requirements of the American Institute of Steel Construction "Steel Construction Manual."
- B. All steel surfaces that come into contact with exposed concrete shall receive a protective coating of an approved heavy bitumastic troweling mastic applied in accordance with the manufacturer's instructions prior to installation.
- C. Where aluminum contacts a dissimilar metal, apply a heavy brush coat of zinc-chromate primer followed by two coats of aluminum metal and masonry paint to the dissimilar metal.
- D. Where aluminum contacts concrete/masonry, apply one coat of TT-P-645B zinc-molybdate primer or a heavy coat of approved alkali resistant bituminous paint to the aluminum or concrete/masonry.
- E. Aluminum Components:
1. Electrolysis protection of materials shall be provided.
 2. Between aluminum grating, aluminum tread plate, or aluminum-stair treads, and steel supports, insert 1/4-in thick neoprene isolator pads, 85 plus or minus 5 Shore-A-Durometer, sized for full width and length of bracket or support.
- F. Floor Hatches: Unless otherwise shown, the CONTRACTOR shall furnish and install a 1½-inch drain line to the nearest floor drain for all floor hatches.
- G. Powder-Driven Pins: Powder-driven pins shall be installed by a craftsman who is certified by the manufacturer as being qualified to install the manufacturer's pins. Pins shall be driven in one initial movement by an instantaneous force that has been carefully selected to attain the required penetration. Driven pins shall conform to the following requirements where "D" = Pin's shank diameter:

Material Penetrated by Pin	Material's Minimum Thickness	Pin's Shank Penetration in Supporting Material	Minimum Space from Pin's CL to Edge of Penetrated Material	Minimum Pin Spacing
Concrete	16D	6D Minimum	14D	20D
Steel	1/4 Inch	Steel Thickness	4D	7D

3.2 WELDING

- A. Method - All welding shall be by the metal-arc method or gas-shielded arc method as described in the American Welding Society's "Welding Handbook" as supplemented by other pertinent standards of the AWS. Qualification of welders shall be in accordance with the AWS Standards governing same.
- B. Welding electrodes shall meet the minimum requirements of E70XX. Filler metal for welds in moment connections shall have a minimum CVN value of 20-ft-lb at 0 degrees F.
- C. Quality - In assembly and during welding, the component parts shall be adequately clamped, supported and restrained to minimize distortion and for control of dimensions. Weld reinforcement shall be as indicated by the AWS Code. Upon completion of welding, all weld splatter, flux, slag, and burrs left by attachments shall be removed. Welds shall be repaired to produce a workmanlike appearance, with uniform weld contours and dimensions. All sharp corners of material that is to be painted or coated shall be ground to a minimum of 1/32-inch on the flat.

3.3 GALVANIZING

- A. All structural steel plates shapes, bars and fabricated assemblies required to be galvanized shall, after the steel has been thoroughly cleaned of rust and scale, be galvanized in accordance with the requirements of ASTM A123. Galvanizing process shall be performed in strict accordance with the requirements of ASTM A384, any galvanized part(s) that become warped as a result of the galvanizing process and/or handling shall be straightened or replaced at no additional expense to the OWNER. Bolts, anchor bolts, nuts and similar threaded fasteners, after being properly cleaned, shall be galvanized in accordance with the requirements of ASTM A153.
- B. Bolts, anchor bolts, nuts, and similar threaded fasteners, after being properly cleaned, shall be galvanized in accordance with the requirements of ASTM A153.
- C. Repair of Damaged Coating:
 - 1. Maximum area that shall be repaired shall comply with applicable sections of ASTM A123.
 - 2. Repair areas by one of the approved methods in accordance with ASTM A780 whenever damage exceeds 3/16" in width. Minimum thickness requirements for the repair are as described in ASTM A123.
 - 3. Field repairs to galvanizing shall be made using "Galva- Guard," "Galvite," or approved equal.
- D. Elements to be painted after galvanizing (duplex-system) shall comply with Section 09970 of the Contract Documents.

3.4 DRILLED ANCHORS

- A. Drilled anchors and reinforcing bars shall be installed in strict accordance with the manufacturer's instructions.
- B. Holes shall be roughened with a brush on a power drill, cleaned and dry.

- C. Drilled anchors shall not be installed until the concrete has reached the specified 28-day compressive strength.
- D. Adhesive anchors shall not be loaded until the adhesive has reached its indicated strength in accordance with the manufacturer's instructions.
- E. Mechanical anchors shall be checked for tightness a minimum of 24 hours after initial installation. Install anchors using the manufacturer's recommended drive units and adapters and in compliance with the manufacturer's recommendations.

3.5 FALL PREVENTION SYSTEM

- A. Fall prevention systems shall be provided on all ladders used to ascend heights exceeding 20 feet.

END OF SECTION

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SECTION 05510 – METAL STAIRS

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. Furnish all labor, materials, equipment and incidentals necessary and install aluminum stairs complete with anchors and brackets, including integral handrails and posts when applicable, as shown on the Drawings and as specified herein.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03300, Cast-in-Place Concrete
- B. Section 05500, Miscellaneous Metals
- C. Section 05520, Aluminum Guardrails and Handrails

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. ASTM International (ASTM):
 - 1. ASTM B221 – Standard Specification for Aluminum and Aluminum Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 - 2. ASTM E985 – Standard Specification for Permanent Metal Railing Systems and Rails for Buildings.
- B. American Institute for Steel Construction (AISC):
 - 1. AISC S326-1978 (Supplement No.1 – 1986) – Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings.
- C. Aluminum Association (AA):
 - 1. Specifications for Aluminum Structures.
 - 2. AA 6061-T6 – Aluminum Sheet and Plates.
- D. American Welding Society (AWS):
 - 1. AWS D1.1 – Structural Welding Code Steel.
- E. American National Standards Institute (ANSI):
 - 1. ANSI A202.1 – Metal Bar Grating Manual for Steel and Aluminum Gratings and Stair Treads.
- F. National Association of Architectural Metal Manufacturers (NAAMM):
 - 1. NAAMM AMP 510 – Metal Stairs Manual.
- G. Occupational Safety and Health Standards (OSHA)

- H. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.4 PERFORMANCE REQUIREMENTS

- A. General – Pre-fabricated Aluminum Stairs shall be designed to withstand structural loads indicated, determine allowable design working stresses based on Aluminum Association (AA) "Specifications for Aluminum Structures."
- B. Structural Performance of Pre-fabricated Aluminum Stairs: Engineer, fabricate, and install to comply with requirements of ASTM E985 for structural performance based on structural computations.
- C. Thermal Movements – Allow for thermal movement resulting from the following maximum change (range) in ambient temperature in engineering, fabricating, and installation to prevent buckling, opening of joints, overstressing of components and connections, and other detrimental effects. Base engineering calculation on actual surface temperatures of materials due to both solar heat gain and nighttime sky heat loss.
- D. Temperature Change (Range): Allowance for thermal movement shall be based on a temperature change of plus and minus 90 degrees F from the average ambient temperature at the project site, or from the temperature at time of installation, whichever is more stringent.
- E. Control of Corrosion – Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1.5 SUBMITTALS

- A. Submit manufacturer's shop drawings, in accordance with Division 1, Shop Drawing Procedures, showing dimensions, material lists, methods of supporting, methods of anchoring and finishes.
- B. Product data for manufacturer's product lines of Pre-fabricated Aluminum Stairs assembled from standard components. Submit product data for grout, anchoring cement, and paint products.
- C. Shop drawings showing fabrication and installation of Pre-fabricated Aluminum Stairs including plans, elevations, sections, details of components, and attachments to other units of Work.
- D. Samples for verification of each type of exposed finish required, prepared on components of same thickness and metal indicated for final unit of Work. Where finishes involve normal color and texture variations, include sample sets showing the full range of variations expected.
- E. Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
- F. Furnish to the ENGINEER a letter signed and sealed by a Civil/Structural Engineer licensed in the State of California that the stair design conforms to the design criteria set forth by the ENGINEER.

- G. Submit to the ENGINEER data showing the location, magnitude and direction of all dead and live load reactions imposed on the structure by the stair and railing system.
- H. Furnish to the ENGINEER Manufacturer's certification that materials meet specification requirements.

1.6 QUALITY ASSURANCE

- A. Single-Source Responsibility – Obtain Pre-fabricated Aluminum Stairs from a single manufacturer.
- B. Engineer Qualifications – A professional engineer legally authorized to practice in the jurisdiction where Project is located and experienced in providing engineering services of the kind indicated that have resulted in the installation of similar stairs to this Project in material, design, and extent and that have a record of successful in-service performance.
- C. All welding shall be performed by qualified welders and shall conform to AWS aluminum welding code, AWS D1.2.
- D. All welding procedures and welder qualification shall be available at the place of manufacture for ENGINEER's review.
- E. Industry Standards – Comply with the provisions of the following standards and specifications:
 - 1. AISC S326
 - 2. NAAMM – AMP-510
 - 3. AWS–D1.1

1.7 DELIVERY, STORAGE AND HANDLING

- A. All materials shall be delivered promptly so as to cause no delay with other parts of the work. Stored materials shall be placed on skids and not on the ground and shall be piled and blocked up so that they will not become bent or otherwise damaged. Materials shall be stored inside a well-ventilated area, away from uncured concrete and protected from weather, moisture, soiling, abrasion, extreme temperatures, and humidity. Materials shall be handled with cranes or derricks as far as practicable. Material shall not be dumped off cars or trucks nor handled in any other way likely to cause damage. Materials with excessive damage, in the opinion of the ENGINEER, shall not be incorporated in the work and shall be removed and replaced with new undamaged materials by the CONTRACTOR at no expense to the OWNER.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. The use of manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.
- B. All like materials shall be the products of one manufacturer or supplier in order to provide standardization of appearance.
- C. Aluminum: ASTM B221, Alloy 6061-T6, Finish AA-C22A31.

- D. Components:
1. Stringers – Aluminum
 2. Headers – Aluminum
 3. Treads – Aluminum
 4. Risers – Aluminum
 5. Platforms – Aluminum
 6. Railings – Aluminum

2.2 HANDRAILS–ALUMINUM

- A. Size members as required by design calculations and to conform to layout details shown. Detail stair risers, treads and landings to conform to the requirements of the current edition of OSHA.
- B. Fabricate stairs, landings and component connections to support a minimum live load of 100-psf with deflection of stairs and landings not to exceed $L/360$. Stairs exceeding vertical height of 12-ft. shall have intermediate landings.
- C. Fabricate railing supports and component connections capable of resisting a lateral force of 200-lbs at any single point, without permanent set or damage.
- D. Fabricate stair with closed risers and closed treads using structural aluminum channels, angles, plates and extrusions for stringers, treads and all supports. Provide closures for exposed ends of stringers.
- E. Fabricate treads from extruded/cast structural aluminum grating with integral nosing to form a one-piece structural unit.
- F. Fabricate landings from extruded/cast structural aluminum grating with integral nosing to form a one-piece structural unit. Construct with perimeter structural aluminum channels as shown, side-supported headers and miscellaneous framing members framing into the stair stringers. Reinforce underside of landings.
- G. Construct stairs to conform to sizes and arrangements indicated; join pieces together by welding wherever possible. Weld assemblies in accordance with recommendations of AWS. Grind all exposed welds to a match and blend with adjoining surfaces.
- H. Provide complete stair assemblies including framing, columns, railings, struts, clips, brackets, bearing plates and all other components necessary for the support of stairs and landings and as required to anchor and contain the stairs on the supporting structure.
- I. Shop assemble sections in largest sizes practical, easily maneuverable through building openings.
- J. Form work true to line and level with accurate angles and surfaces and straight sharp edges. Ease exposed edges to radius of approximately 1/32-in. Form bent metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

PART 3 EXECUTION

3.1 ERECTION

- A. Erect stairs square, level, plumb and free from distortion or defects detrimental to appearance and performance.
- B. Provide necessary anchors, plates, angles, hangers and struts as required for connecting stairs to the structure.
- C. Ensure alignment with adjacent construction. Coordinate with related work to ensure no interruption in installation.
- D. Perform necessary cutting and altering for the installation of work of other Sections. Do not perform any other additional cutting without review of the ENGINEER.
- E. Field bolt and weld to match standard of shop bolting and welding. Hide bolts and screws whenever possible. Where not hidden, use flush countersunk fastenings, unless indicated otherwise. Make mechanically fastened joints flush hairline butted. Grind welds smooth and flush.

3.2 PROTECTION

- A. Protect aluminum fabrications from damage due to work of adjacent trades.

3.3 CLEANING

- A. As work progresses, remove debris and leave installation sites broom clean.
- B. Prior to final acceptance, clean stairs of any paint, mud or other adherents.

END OF SECTION

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SECTION 05520– ALUMINUM HANDRAILS AND GUARDRAILS

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. Furnish all labor, materials, equipment, incidentals, and services necessary to install ornamental aluminum guardrails and handrails as shown on the Drawings and as specified herein.
- B. Related Work Specified Elsewhere:
 - 1. Section 03600, Grout
 - 2. Section 05500, Miscellaneous Metals

1.2 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. ASTM International (ASTM)
 - 1. ASTM-B210 - Standard Specification for Aluminum and Aluminum Alloy Drawn Seamless Tube.
 - 2. ASTM-B221 - Standard Specification for Aluminum and Aluminum Alloy Extruded Bars, Rods, Wires, Profiles, and Tubes.
 - 3. ASTM-B429 - Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
 - 4. ASTM-E488 - Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements.
 - 5. ASTM-E985 - Standard Specification for Permanent Metal Railing Systems and Rails for Buildings.
- B. Society for Protective Coatings (SSPC)
 - 1. SSPC-Paint 12 - Cold Applied Asphalt Mastic (Extra Thick Film).
- C. National Association of Architectural Metal Manufacturers (NAAMM)
 - 1. Metal Finishes Manual.
- D. Aluminum Association (AA)
 - 1. AA-M12C22A41 - M12 – Mechanical Finish, Non-Specular; C22 – Finish, Medium Matte; A41 – Clear Anodic Coating, Class I
- E. American Architectural Manufacturers Association (AAMA)
 - 1. AAMA 607.1
- F. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.3 SUBMITTALS

- A. Submit, in accordance with Division 1, Shop Drawing Procedures, product data for manufacturer's product lines of guardrails and handrails assembled from standard components.
 - 1. Shop Drawing Procedures, shop drawings showing fabrication and installation of guardrails and handrails including plans, elevations, sections, details of components, gates, and attachments to other units of Work.
 - 2. For installed guardrails and handrails indicated to comply with certain design loadings, include structural analysis data, sealed and signed by the qualified Professional Engineer who was responsible for their preparation.
 - 3. Samples – Samples for verification of each type of exposed finish required, prepared on components indicated below of same thickness and metal indicated for final unit of Work. Where finishes involve normal color and texture variations, include sample sets showing the full range of variations expected.
 - 4. Samples – 6-inch-long sections of each distinctly different linear guardrail member, including handrails, top rails, posts, and balusters.
 - 5. Shop Drawing Procedures, qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
- B. Testing – Testing Laboratory Services, product test reports from a qualified independent testing agency evidencing compliance of guardrails and handrails with requirements based on comprehensive testing of current products.
- C. Certification – Testing Laboratory Services, test reports from independent testing agency evidencing compliance of guardrails and handrails with ASTM E985.

1.4 QUALITY ASSURANCE

- A. Single-Source Responsibility – Obtain guardrails and handrails of each type and material from a single manufacturer.
- B. All welding shall be performed by qualified welders and shall conform AWS aluminum welding code, AWS D1.2.
- C. All welding procedures and welder qualification shall be available at the place of manufacture for ENGINEER's review.
- D. Engineer Qualifications - A Professional Civil or Structural Engineer licensed in the State of California and experienced in providing engineering services of the kind indicated that have resulted in the installation of guardrails and handrails similar to this Project in material, design, and extent and that have a record of successful in-service performance.

1.5 PERFORMANCE REQUIREMENTS

- A. General – In engineering guardrail and handrails to withstand structural loads indicated, determine allowable design working stresses of guardrail materials based on Aluminum Association (AA) "Specifications for Aluminum Structures".

- B. Structural Performance of Guardrails and Handrails – Engineer, fabricate, and install guardrails and handrails to comply with requirements of ASTM E985 for structural performance based on structural computations.
 - C. Thermal Movements – Allow for thermal movement resulting from the following maximum change (range) in ambient temperature in engineering, fabricating, and installing guardrails and handrails to prevent buckling, opening of joints, overstressing of components and connections, and other detrimental effects. Base engineering calculation on actual surface temperatures of materials due to both solar heat gain and nighttime sky heat loss.
 - D. Temperature Change (Range): Allowance for thermal movement shall be based on temperature change of plus or minus 90 degrees-F from the average ambient temperature at the project site, or from the temperature at time of installation, whichever is more stringent.
 - E. Control of Corrosion – Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.
- 1.6 DELIVERY, STORAGE AND HANDLING
- A. Store guardrails and handrails inside a well-ventilated area, away from uncured concrete and protected from weather, moisture, soiling, abrasion, extreme temperatures, and humidity.
- 1.7 PROJECT CONDITIONS
- A. Field Measurements – Where guardrails and handrails are indicated to fit to other construction, CONTRACTOR shall check actual dimensions of other construction by accurate field measurements before fabrication. CONTRACTOR shall provide field measurements to manufacturer/supplier such that they may be shown on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. The use of manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.
- B. All like materials shall be the products of one manufacturer or supplier in order to provide standardization of appearance.

2.2 MANUFACTURERS

- A. Available Manufacturers – Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:
 - 1. Julius Blum & Co., Inc.
 - 2. Blumcraft of Pittsburgh.
 - 3. J.G. Braun Co.

4. Newman Brothers, Inc.

5. Approved equal

2.3 METALS

- A. General – Provide metal free from surface blemishes where exposed to view in the finished unit. Exposed-to-view surfaces exhibiting pitting, seam marks, roller marks, stains, discolorations, or other imperfections on finished units are not acceptable.
- B. Aluminum – Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of the alloy and temper designated below for each aluminum form required.
 - 1. Extruded Bar and Tube: ASTM B221, alloy 6063-T5/T52.
 - 2. Extruded Structural Pipe and Tube: ASTM B429, 6063-T6.
 - 3. Drawn Seamless Tube: ASTM B210, 6063-T832.
 - 4. Plate and Sheet: ASTM B209, 6061-T6.
 - 5. Die and Hand Forgings: ASTM B247, 6061-T6.
 - 6. Castings: ASTM B26, A356-T6.

2.4 FASTENERS

- A. Fasteners for Anchoring Guardrails to Other Construction – Select fasteners of the type, grade, and class required to produce connections that are suitable for anchoring guardrail to other types of construction indicated and capable of withstanding design loadings.
 - 1. For aluminum guardrails, provide fasteners fabricated from Type 304 or Type 316 Stainless Steel.
- B. Fasteners for Interconnecting Guardrail Components – Use fasteners of same basic metal as the fastened metal, unless otherwise indicated. Do not use metals that are corrosive or incompatible with materials joined.
 - 1. Provide concealed fasteners for interconnecting guardrail and handrail components and for attaching them to other work, except where exposed fasteners are unavoidable or are the standard fastening method for guardrail and handrail system indicated.
 - 2. Provide Phillips flathead machine screws for exposed fasteners, unless otherwise indicated.
- C. Cast-in-Place and Post installed Anchors – Anchors of type indicated below, fabricated from corrosion-resistant materials. Except where more stringent requirements are indicated below, provide anchors with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry and equal to 4 times the load imposed when installed in concrete, as determined by testing per ASTM E488 conducted by a qualified independent testing agency.

1. Cast-In-Place Anchors – Comply with CBC Section 1911 or 1912 for cast-in-place anchor values.
2. Expansion Anchors – Comply with requirements of Section 05500.
3. Adhesive Anchors – Comply with requirements of Section 05500.

2.5 PAINT

- A. Bituminous Paint – Cold-applied asphalt mastic complying with SSPC-Paint 12, except containing no asbestos fibers.

2.6 GROUT AND ANCHORING CEMENT

- A. Comply with requirements of Section 03600.

2.7 FABRICATION

- A. General – Fabricate guardrails and handrails to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of hollow members, post spacing, and anchorage, but not less than that required to support structural loads.
- B. Assemble guardrail systems in shop to the greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.
- C. Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain profile of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of guardrail and handrail components.
- D. Non-welded Connections – Fabricate guardrails and handrails by connecting members with guardrail manufacturer's standard concealed mechanical fasteners and fittings, unless otherwise indicated. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.
- E. Brackets, Flanges, Fittings, and Anchors: Provide manufacturer's standard wall brackets, flanges, miscellaneous fittings, and anchors to connect guardrail and handrail members to other construction.
- F. Provide inserts and other anchorage devices to connect guardrails and handrails to concrete work. Fabricate anchorage devices capable of withstanding loads imposed by guardrails and handrails. Coordinate anchorage devices with supporting structure.
- G. For removable railing posts, fabricate slip-fit sockets from aluminum pipe whose inside diameter is sized for a close fit with posts and to limit deflection of post without lateral load, measured at top, to not more than 1/12 of post height. Provide socket covers designed and fabricated to resist accidental dislodgement.
- H. Shear and punch metals cleanly and accurately. Remove burrs from exposed cut edges.

- I. Ease exposed edges to a radius of approximately 1/32 inch, unless otherwise indicated. Form bent-metal corners to the smallest radius possible without causing grain separation or otherwise impairing work.
- J. Cut, reinforce, drill, and tap components, as indicated, to receive finish hardware, screws, and similar items.
- K. Provide weep holes or other means to drain entrapped water in hollow sections of guardrail members that are exposed to exterior or to moisture from condensation or other sources.
- L. Fabricate joints that will be exposed to weather in a watertight manner.
- M. Close exposed ends of guardrail and handrail members with prefabricated end fittings.
- N. Provide wall returns at ends of wall-mounted handrails, unless otherwise indicated. Close ends of returns unless clearance between end of the handrail and wall is ¼-inch or less.
- O. Toe Boards – Where indicated, provide toe boards at guardrails around openings and at the edge of open-sided floors and platforms. Fabricate to dimensions and details indicated.
- P. Fillers – Provide steel sheet or plate fillers of thickness and size indicated or required to support structural loads of handrails where needed to transfer wall bracket loads through wall finishes to structural supports. Size fillers to suit wall finish thickness. Size fillers to produce adequate bearing to prevent bracket rotation and overstressing of substrate.
- Q. Gates – Provide swing-type gates where indicated. Unless otherwise shown, fabricate gates with components to match adjacent guardrails. Furnish gates with aluminum or stainless steel hinges and keeper/latch mechanism.

2.8 FINISH

- A. Comply with NAAMM "Metal Finishes Manual" for recommendations relative to applying and designating finishes.
- B. Finish designations prefixed by AA conform to the system established by the Aluminum Association for designating aluminum finishes.
- C. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: non-specular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.7 mil or thicker) complying with AAMA 607.1.

PART 3 EXECUTION

3.1 PREPARATION

- A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installing anchorages, such as sleeves, concrete inserts, anchor bolts, and miscellaneous items having integral anchors, that are to be embedded in concrete construction. Coordinate delivery of such items to Project site.

3.2 INSTALLATION - GENERAL

- A. Fit exposed connections accurately together to form tight, hairline joints.

- B. Cutting, Fitting, and Placement – Perform cutting, drilling, and fitting required for installing guardrails and handrails. Set guardrails and handrails accurately in location, alignment, and elevation, measured from established lines and levels and free from rack.
 - 1. Do not weld, cut, or abrade surfaces of guardrail and handrail components that have been coated or finished after fabrication and are intended for field connection by mechanical or other means without further cutting or fitting.
 - 2. Set posts plumb.
 - 3. Align rails so that variations from level for horizontal members and from parallel with rake of steps and ramps for sloping members do not exceed 1/4-inch in 12 feet.
- C. Corrosion Protection – Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.
- D. Adjust guardrails and handrails prior to anchoring to ensure matching alignment at abutting joints. Space posts at interval indicated but not more than that required by structural loads.
- E. Fastening to In-Place Construction – Use anchorage devices and fasteners where necessary for securing guardrails and handrails and for properly transferring loads to in-place construction.

3.3 GUARDRAIL CONNECTIONS

- A. Non-welded Connections – Use mechanical joints for permanently connecting guardrail components. Seal recessed holes of exposed locking screws using plastic filler, cement colored to match finish of guardrails and handrails.
- B. Expansion Joints: Install expansion joints at locations indicated but not further apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 2-inches beyond joint on either side; fasten internal sleeve securely to one side; locate joint within 6-inches of post.

3.4 ANCHORING POSTS

- A. Anchor posts in concrete by forming or core-drilling holes not less than 6-inches deep and 3/4-inch greater than outside diameter of post. Clean holes of all loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's directions.
- B. Leave anchorage joint exposed, wipe off surplus anchoring material, and leave 1/8-inch buildup, sloped away from post.
- C. Anchor posts to metal surfaces with oval flanges, angle type or floor type as required by conditions, connected to posts and to metal supporting members as follows:
 - 1. For aluminum guardrails, attach posts as indicated using fittings designed and engineered for this purpose.
- D. Install removable guardrail sections where indicated in slip-fit metal sockets cast into concrete. Accurately locate sockets to match post spacing.

3.5 ANCHORING RAIL ENDS

- A. Anchor rail ends into concrete with round flanges connected to rail ends and anchored into wall construction with post installed anchors and bolts.
- B. Anchor rail ends to metal surfaces with oval or round flanges.
 - 1. Connect flanges to rail ends using non-welded connections.

3.6 ATTACHING HANDRAILS TO WALLS

- A. Attach handrails to wall with wall brackets and end fittings. Provide bracket with 1½ - inches clearance from inside face of handrail and finished wall surface.
- B. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
- C. Secure wall brackets and wall return fittings to building construction as follows.
 - 1. Use type of bracket with predrilled hole for exposed bolt anchorage.
 - 2. For concrete anchorage, use drilled-in expansion shield and either concealed hanger bolt or exposed lag bolt, as applicable.
 - 3. For steel-framed gypsum board assemblies, fasten brackets directly to steel framing or concealed reinforcements using self-tapping screws of size and type required to support structural loads.

3.7 ADJUSTING AND CLEANING

- A. Clean soiled surfaces by washing thoroughly with clean water and soap, followed by rinsing with clean water.

3.8 PROTECTION

- A. Protect finishes of guardrails and handrails from damage during construction period with temporary protective coverings approved by guardrail manufacturer. Remove protective coverings at the time of Final Completion.
- B. Restore finishes damaged during installation and construction period so that no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units at no additional cost to the OWNER.

END OF SECTION

SECTION 09960 – PROTECTIVE COATINGS

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The scope of work includes wash down, surface preparation, coating application, touch-up, protection of uncoated surfaces, containment of airborne debris, waste disposal, cleanup, and all appurtenant work. The specified coating systems shall be applied only to the surfaces and miscellaneous pipes as described in this Section.
- B. These surfaces include, but are not limited to the Headworks and the South Primary Contractor shall also repair all existing coatings at the project site that are damaged as a result of the Work performed within the Contract Documents.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01330 - Submittal Process

1.3 REFERENCED STANDARDS, CODES, AND REGULATIONS

- A. ASTM: American Society for Testing and Materials, International
 - 1. D4262: Standard Test Method for pH of Chemically Cleaned or Etched Concrete Surfaces
 - 2. D4263: Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method
 - 3. D4414: Standard Practice for Measurement of Wet Film Thickness of Organic Coatings by Notched Gauges
 - 4. D5402: Standard Practice for Assessing the Solvent Resistance of Organic Coatings Using Solvent Rubs
 - 5. D7091: Standard Practice for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to Ferrous Metals and Nonmagnetic, Nonconductive Coatings Applied to Non-Ferrous Metals
- B. CCR: California Code of Regulations Title 8, Industrial Relations
 - 1. Section 1670: Personal Fall Arrest Systems, Personal Fall Restraint Systems and Positioning Devices
 - 2. Section 5157: Permit Required Confined Spaces
 - 3. Section 1532.1: Containment, Disposal, and Safety Requirements for Lead
- C. SSPC: Steel Structures Painting Council, the Society for Protective Coatings
 - 1. PA 1 Shop, Field, and Maintenance Painting of Steel
 - 2. PA 2 Measurement of Dry Film Thickness with Magnetic Gauges

3. QP 1 Qualification Procedure 1 for Field Coating
4. QP 3 Qualification Procedure 3 for Shop Painting
5. SP1 Solvent Cleaning
6. SP2 Hand Tool Cleaning
7. SP3 Power Tool Cleaning
8. SP7 Brush Off Blast Cleaning
9. SP10 Near White Blast Cleaning
10. SP11 Power Tool Cleaning to Bare Metal
11. SP 13 Surface Preparation of Concrete
12. VIS 3 Guide and Reference Photographs for Steel Surfaces Prepared by Hand and Power Tool Cleaning
13. Vol. 1 Good Painting Practice

D. NSF National Sanitation Foundation

1. NSF 61 Drinking Water System Components

1.4 SUBMITTALS

- A. The Contractor shall submit the following in accordance with the requirements in Section 01300, Submittals. The Contractor shall submit the following prior to mobilizing to the project site:
1. The Contractor shall provide SSPC QP 1 Certification.
 2. Qualifications of the Field Applicator: Copy of an active State of California C 33 Contractor's license as required for the application of coatings.
 3. Provide 3 references which show that the Contractor has previous successful experience with each specified or comparable coating systems in the past 5 years. Include the name, address, and the telephone number for the owner of each installation for which the Contractor applied the protective coating.
 4. Provide a written letter from the Contractor stating that they are certified by the manufacturer and experienced in the application of the specified coating systems in the past 5 years. The letter shall state the manufacturer and model number of mixing, heating, and pumping equipment to be used to apply the specified coating system.
- B. Complete data on each type of coating, primer, caulking, adhesive, and materials shall be submitted for review. Acceptance shall be received from the District before the materials are delivered to the jobsite. This procedure shall be followed whether or not the material that the Contractor proposes to use is named in the Contract Documents. Submitted data shall show where and for what uses each paint product is proposed

with cross-reference made to sections of these Specifications. Paint material submittals shall include the following:

1. Material safety data sheets for all products used at the jobsite including paints, thinners, solvents, and cleaners.
 2. Product Data Sheets for all primers, concrete surface fillers, caulking, adhesives, and coating products with the following information:
 - a. Surface preparation requirements for immersion service
 - b. Minimum and maximum wet and dry film thickness per coat
 - c. Minimum and maximum cure, induction, and pot life times
 - d. Temperature and humidity requirements during and after application
 - e. Proper storage and shelf life at various temperatures
 - f. EPA Method 24 results to verify compliance with BAAQMD Rule 8-3 for VOC's
 - g. Tensile, elongation, moisture vapor transmission rate, and abrasion testing results.
- C. Manufacturer's product data sheet for each abrasive material to be used with the following:
1. Technical data sheet for each product used, including statements on the suitability of the material for the intended use.
 2. State and country of origin.
 3. Material safety data sheet for each product, if applicable.
 4. Size/mesh and percentage by weight of each component
- D. Samples: During the coating application, the Contractor shall submit three coating samples of the 100% solids coating on 6-inch by 6-inch sheet concrete mortar samples. Each sample shall be abrasive blasted and completely coated over its entire surface with the complete coating system including primers.
- E. Coating Manufacturer's Information: For each coating system to be used, the Contractor shall submit the following listed data at least 14 days prior to application:
1. Coating manufacturer's technical application instructions for application, heating materials, mixing, spray tip sizes, and hose pressures.
 2. The manufacturer shall provide written certification that the coating Contractor's supervisor and each applicator performing Work on the project have been trained and approved by the manufacturer to apply the selected coating system. The manufacturer shall state whether or not it has verified that the Contractor is going to use the proper mixing, coating application, heating, and environmental control equipment for the specified coating products.

1.5 QUALITY ASSURANCE

- A. Pre-construction meeting: The Contractor's project manager shall attend a pre-construction meeting at least three weeks before start of application of the coating

systems. It shall also be attended by the Owner, Coating Inspector, and Contractor's health and safety officer. The meeting shall include a discussion on the following:

1. Health and safety
2. Shutdown plan and schedule
3. Environmental controls and containment requirements
4. Protection of surfaces not scheduled to be coated
5. Staging of equipment
6. Field quality control
7. Cleaning
8. Contractor/Inspector/Owner Relationship
9. Communication protocol
10. Coordination with regular maintenance work or other projects
11. Dust control

B. The Contractor shall provide satisfactory documentation from the manufacturer of the proposed substitute material that said material meets the requirements and is equivalent to or better than the listed materials in the following properties:

1. NSF Standard 61 or UL Water approval
2. Minimum and maximum recoat times with itself and with topcoats
3. Minimum and maximum cure times for immersion
4. Abrasion Resistance per ASTM D4060 using a CS17 Wheel
5. BAAQMD Rule 8-3 VOC compliance
6. Dry film thickness per coat
7. Compatibility with other coatings
8. Suitability for the intended service on steel or concrete
9. Resistance to chemical attack
10. Temperature limitations in service and during application
11. Type and quality of recommended undercoats and topcoats
12. Ease of application
13. Ease of repairing damaged areas

14. Stability of colors
15. Minimum adhesion of 100% solids epoxy shall be 1,000 P.S.I. as per ASTM D-4541 using a Type II instrument.
16. 100% solids polyurethane return to service time shall be less than 56 hours @ 77 degrees

1.6 HEALTH AND SAFETY

- A. In accordance with the requirements of CCR Title 8 Section 5157, the Contractor shall provide and require the use of personal protective and lifesaving equipment for all persons working in confined spaces.
- B. Head and face protection and respiratory devices shall include protective helmets conforming to the requirements of ANSI Z 89.1-2009 which shall be worn by all persons at all times while in the vicinity of the work when coatings are being applied. In addition, workers engaged in or near the work during sandblasting shall wear eye and face protection devices meeting the requirements of ANSI Z 87.1-2010 and a respirator with appropriate filter.
- C. Where ventilation is used to control potential exposures to workers, as set forth in Section 1910.94 of the OSHA Regulations for Construction, ventilation shall be adequate to reduce the concentration of the air contaminant to the degree that a hazard to the worker does not exist. Methods of ventilation shall meet the requirements set forth in ANSI Z9.2-2006.
- D. Temporary ladders and scaffolding shall conform to the applicable requirements of CCR Title 8 Section 1676 and Section 1670. The Contractor shall submit scaffolding plans to the District for review.

1.7 INSPECTION AND TESTING COORDINATION

- A. The Contractor shall give the District's Coatings Inspector a minimum of 2 days of advance notice of the start of any field surface preparation work for coating application work.
- B. All such work shall be performed only in the presence of the Inspector unless Inspector has granted prior approval in writing to perform such work in his/her absence.
- C. Inspection by the Inspector, or the waiver of inspection of any particular portion of the work, shall not relieve the Contractor of its responsibility to perform the work in accordance with these Specifications.
- D. The Contractor shall hold all surface preparation and coating application operations until Inspector approves the following inspection points: concrete surface preparation mock up sample area following completion of blasting; completion of concrete resurfacing; primer application; coating application and testing of cured coating.
- E. Scaffolding shall be erected and moved to locations where requested by Inspector to facilitate inspection. Additional illumination shall be provided to cover all areas to be inspected.

1.8 RECORDS

- A. The Contractor shall maintain an accurate, written record of the quantity of coating material applied and the corresponding surface area covered, a description of the area coated, the batch number, surface temperature, ambient temperature, relative humidity, dewpoint, and applicator on a daily basis. The Contractor shall furnish a signed copy of said record to the Inspector at the beginning of the next working day. These quantities shall be independently verified by the Inspector and reported on the Inspector's log. The Inspector shall immediately investigate and resolve any discrepancies between these reported quantities.

1.9 MANUFACTURER'S PARTICIPATION

- A. The Contractor shall require the protective coating manufacturer to furnish a qualified technical representative to visit the project site for technical support and as necessary to resolve field problems attributable to or associated with the manufacturer's products furnished under this Contract or the application thereof. The manufacturer's representative shall be onsite at the end of the surface preparation, during mixing and the start of the application, and during any relining work as required by the District, at no additional cost to the District.

1.10 WARRANTY

- A. The Contractor and coating manufacturers shall warrant the coating system applications against defects and workmanship after final acceptance of the Work for a period of 1 year. The Contractor shall perform all Work and supply all equipment and materials associated with the repair of failures identified in the warranty inspection at no cost to the District.
- B. The material manufacturer shall warrant for a period of 1 year that its products meet published physical properties and that they are free of manufacturing defects.
- C. The material manufacturer shall replace any defective product and the Contractor shall, within a reasonable time after receipt of written notice thereof, repair defects in materials or workmanship which may develop during the warranty period, and any damage to other work caused by such defects or the repairing of same, at his own expense and without cost to the District.

PART 2 PRODUCTS

2.1 GENERAL

- A. Definitions: The term "paint", "coatings", or "finishes" as used herein, shall include surface treatments, powders, enamels, paints, epoxy resins, and all other protective coatings, excepting galvanizing or anodizing, whether used as a pretreatment, primer, intermediate coat, or finish coat. The term "DFT" means minimum dry film thickness.
- B. General: Coating materials shall be sealed in new containers that plainly show the designated name, formula or specification number, batch number, color, date of manufacture, manufacturer's directions, and name of manufacturer, all of which shall be plainly legible at the time of use.
- C. The CONTRACTOR shall use coating materials suitable for the intended use and recommended by their manufacturer for the intended service.

- D. Compatibility: In any coating system, only compatible materials from a single manufacturer shall be used in the work. Particular attention shall be directed to compatibility of primers and finish coats.
- E. Colors: All colors and shades of colors of all coats of paint shall be as selected or specified by the DISTRICT.
- F. Protective Coating Materials: Products shall be standard products produced by recognized manufacturers who are regularly engaged in production of such materials for essentially identical service conditions. Where requested, the CONTRACTOR shall provide the DISTRICT with the names of not less than 5 successful applications of the proposed manufacturer's products demonstrating compliance with this specification requirement.
- G. Substitute or "Or-Equal" Submittals: Coating materials suitable for immersion and non-immersion and recommended by their manufacturer for wastewater fluids, liquid, and gases shall be applied. Unless otherwise specified, materials are from the catalogs of the companies listed herein. Materials by other manufacturers are acceptable provided that they are established as being compatible with and of equal quality to the coatings of the companies listed and accepted by the ENGINEER. The CONTRACTOR shall provide satisfactory documentation from the firm manufacturing the proposed substitute or "or-equal" material that said material meets the specified requirements and is equivalent to or better than the listed materials in the following properties:
 - 1. Minimum and Maximum Cure Times
 - 2. Moisture Vapor Transmission Rate per ASTM D1653 Method B at 60 mils minimum
 - 3. Abrasion Resistance per ASTM D4060 using a CS17 Wheel
 - 4. Minimum and Maximum Recoat Times
 - 5. Solids content by volume
 - 6. Dry film thickness per coat
 - 7. Compatibility with other coatings
 - 8. Suitability for wastewater solids, liquids, and gases
 - 9. Resistance to chemical attack
 - 10. Temperature limitations in service and during application
- H. The cost of all testing and analysis of the proposed substitute materials that may be required by the DISTRICT shall be paid by the CONTRACTOR. If the proposed substitution requires changes in the Contract work, the CONTRACTOR shall bear all such costs involved and the costs of allied trades affected by the substitution.

2.2 COATING SYSTEMS

- A. Material Sources: Each of the following manufacturers is capable of supplying many of the industrial coating materials specified herein. Where manufacturers and paint

numbers are listed, it is to show the type and quality of coatings that are required. Proposed substitute materials shall be shown to satisfy the material descriptions and to equal or exceed the properties of the listed materials as required in the paragraph entitled "Substitute or 'Or-Equal' Submittals" herein.

1. Raven Lining Systems
 2. Sauereisen
 3. Sprayroq
- B. ACYL – Single component, water based acrylic latex with a fungicide additive shall have a minimum solids content of 35% by volume. Prime coat shall be as recommended by manufacturer. The coating material shall be available in the ANSI safety colors.
1. Prime coat (DFT = 2 mils), as recommended by manufacturer for substrate.
 2. Finish coats (DFT = 6 mils), Amercoat 220, Sherwin Williams Pro Industrial Acrylic, or equal.
 3. Total system DFT = 8 mils.
- C. ACY – High molecular weight acrylic coating material shall have a minimum solids content of 35% by volume. Prime coat shall be an acrylic filler and sealer for concrete surfaces.
1. Prime coat (Filler/sealer), Tnemec Series 130 Envirofill, Sanitile 100, or equal.
 2. Finish coats (2 or more, DFT = 3 mils), Tnemec Series 6 Tneme-Cryl, Carboline 3359 Flat, or equal.
- D. BIT – Bituminous: To be used for the isolation of ferrous and non-ferrous metals from concrete and for the exterior of buried piping that is not coated with petrolatum tape or polyethylene encasement. Approved Products include the following:
1. Finish Coat (1 coat at 20 mils DFT), Tnemec 46-465, Bitumastic 300, Christy's HD50, or equal (8 mils).
- E. CML – Cement Mortar Coating: A 1-1/2-inch minimum thickness mortar coating reinforced with 3/4-inch galvanized welded wire fabric shall be provided. The cement mortar shall contain no less than 1 part Type II cement to 3 parts sand. The cement mortar shall be cured by a curing compound meeting the requirements of "Liquid Membrane-Forming Compounds for Curing Concrete" ASTM C 309-81, Type II, white pigmented, or by enclosure in an 8-mil thick polyethylene sheet with all joints and edges lapped by at least 6 inches.
- F. CTE - Coal Tar Epoxy: High build, two-component amine cured coal tar epoxy shall have a solids content of at least 68% by volume, suitable for long term immersion in wastewater and for coating of buried surfaces, and conforming to DOD P 23236, Class 2, or to SSPC Paint 16. Prime coats are for use as a shop primer only. Prime coat shall be omitted when both surface preparation and coating are to be performed in the field.

1. Finish coats (2 or more, DFT = 16 mils), Amercoat 78 HB, International Paint Devtar 5A-HS, or equal.
 2. Total system DFT = 16 mils.
- G. DIP1 – Ceramic Epoxy shall be used to line the interior surfaces of ductile iron pipe exposed to high solids sludge. Ceramic Epoxy lining shall be used for all solids processing piping 10 inches diameter and larger. Approved Products include the following:
1. Finish coat (1 coat at 30 mils DFT), Protecto 401 as manufactured by Induron Coatings, Inc.
- H. DIP2 - Novalac Epoxy shall be used to line the interior surfaces of ductile iron pipe exposed to municipal sludge. Approved products include the following:
1. Finish coat (1 coat at 40 mils DFT), SP2000W as manufactured by Superior Environmental Products.
- I. DIP3 – Glass Lining: To be used to line the interior surfaces of steel or ductile iron pipe exposed to solids processing piping. Approved products include the following:
1. Finish coat (10 mils DFT), SG-14, manufactured by VITCO, MEH-32 as manufactured by Ferrock, or equal.
- J. EAP – Epoxy and Aliphatic Polyurethane. Primer shall be a rust inhibitive two-component epoxy coating with a minimum solids content of 70% by volume. Two-component aliphatic acrylic or polyester polyurethane coating material shall provide superior color and gloss retention under UV exposure, resistance to splash from acid and alkaline chemicals, resistance to chemical fumes and severe weathering and with a minimum solids content of 58% by volume.
1. Prime coat (DFT = 4 mils), Amerlock 2, Carboguard 890, Sherwin Williams Macropoxy 646, or equal.
 2. Finish coat (one or more, DFT = 3 mils), Amershield VOC, Carbothane 133 VOC, Sherwin Williams Hi Solids Polyurethane 250, or equal.
 3. Total system DFT = 7 mils.
- K. EF – Epoxy Filler, Concrete with Surface Voids: High build epoxy filler compound, shall have a solids content of 100% by volume, suitable for long term immersion in water and for coating of buried surfaces and conforming to DOD P 23236, Class 2, or to SSPC Paint 16. Filler-surfacer compound shall be a two-component epoxy material used to fill concrete bugholes, honeycomb, thin cracks, voids, and rough areas greater than 1/8 of an inch in depth or 1/4 of an inch in width. The seal coat provides a smooth surface for the application of the coal tar epoxy. The seal coat is a two-component epoxy material with 100% solids and is applied to the entire concrete surface and worked into the concrete surface with a wide blade putty knife or a squeegee.
1. As required to provide an even surface prior to primer and finish coating, Nu-Klad 114A, Tnemec Series 218 Mortarclad, or equal.

- L. EFEP - Epoxy Filler/Epoxy Phenolic, Concrete with Surface Voids: Epoxy-phenolic amine cured resin with a solids content of at least 55% by volume, and suitable for long-term immersion in water and exposure to the effects of hydrogen sulfide gas where there is the probability of sulfuric acid formation on the surfaces. The filler-sealer shall be a 100% solids amine cured epoxy material with silica and inert fillers. A 100% solids epoxy surfacer shall be used to fill holes and patch the concrete surfaces after abrasive blasting.
1. Prime coat (filler-sealer), applied in two coats to the entire surface using a squeegee to achieve a smooth, void-free surface, Plasite 9029, Amerlock Sealer followed by Nu-Klad 114A, Tnemec Series 218, or equal.
 2. Finish coats (Two or more coats, DFT = 12 mils), Plasite 7122, Amercoat 90HS, Tnemec 435 at 12 to 20 mils DFT, or equal. On stairways and in walking and working areas use Plasite 7122 HAR or use Amercoat 346 with Amercoat 886 non-skid additive in the final coat.
 3. Two or more coats, DFT = 125+ mils, Plasite 7122, Amercoat 90HS, Tnemec 434 at 125 mils DFT topcoated with Tnemec 435 at 12 to 20 mils DFT, or equal
- M. EP – Epoxy Phenolic: Epoxy-phenolic amine cured resin with a solids content of at least 55% by volume, and suitable for long-term immersion in water and exposure to the effects of hydrogen sulfide gas where there is the probability of sulfuric acid formation on the surfaces.
1. Prime coat and finish coats (3 or more, DFT = 12 mils), Plasite 7122, Amercoat 90HS, Tnemec 435, or equal.
- N. ENS – Epoxy Non-Skid Floor Coating: Epoxy primer, two-component epoxy non-skid and aliphatic polyurethane floor surfacing shall be formulated to resist and sunlight without staining. Products shall be as follows, or equal:
1. Prime Coat (1 coat at 6 to 8 mils), Amercoat 235 Multi-Purpose Epoxy Coating
 2. Finish Coat (1 coat at 5 to 10 mils), Amercoat 237M Heavy Duty Epoxy Non-Skid Coating
 3. Total system DFT = 11 to 18 mils
- O. E1 – Amine cured Epoxy, Indoor and Immersion Exposure: High-Build, amine cured, straight epoxy resin shall have a solids content of at least 70% by volume and be suitable for long-term wastewater exposure. The following products are approved:
1. Prime Coat (DFT = 5 to 6 mils), Carboline Carboguard 890, PPG Amercoat Amerlock 2 VOC, Sherwin Williams Macropoxy 646, or equal
 2. Total System DFT: 5 to 6 mils
- P. E2 – Amine Cured Epoxy, Indoor and Immersion Exposure: High-build, amine cured, straight epoxy resin shall have a solids content of at least 70% by volume and shall be suitable for long-term wastewater exposure. The following products are approved:
1. Intermediate Coat (DFT = 5 to 6 mils), Carboline Carboguard 890, PPG Amercoat Amerlock 2 VOC, Sherwin Williams Macropoxy 646, or equal

2. Final Coat (DFT = 5 to 6 mils), PPG Amercoat Amerlock 2 VOC, Sherwin Williams Macropoxy 646, or equal
 3. Total System DFT: 10 to 12 mils
- Q. E100 – 100% Solids Epoxy: To be used to line the interior surfaces of steel pipe or concrete exposed to municipal potable water. It shall be NSF Standard 61 approved for potable water exposure. Approved products include the following:
1. Raven Lining Systems Raven 405, International Paint Enviroline 230 as manufactured by International Paint.
 2. Finish coat: 1 coat at 60 mils DFT
- R. FBE – Fusion Bonded Epoxy: The coating material shall be a 100% powder epoxy applied in accordance with the AWWA C213 "AWWA Standard for Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines", except that the surface preparation shall be as specified in the coating system schedule of this section. The coating shall be applied using the fluidized bed process for steel less than 24 inches in height. Electrostatic FBE will require prior approval by the Owner.
1. Liquid Epoxy: For field repairs or where, as confirmed by the Inspector, it would be impossible to use the powder epoxy method without causing damage to the item, the use of a liquid epoxy will be permitted, applied in not less than 3 coats to provide a DFT of 15 mils. The liquid epoxy shall be a 100% solids epoxy recommended by the powder epoxy manufacturer.
 2. Coating (DFT = 16 mils), Scotchkote 206N, or equal.
 3. Total system DFT = 16 mils.
- S. JTS – Joint Sealant – Joint sealant shall be installed over expansion joints greater than ¼-inch in width. Approved products include the following:
1. Prime Coat (DFT = as recommended by manufacturer), Sika Sikaflex Primer 429, Masterseal P173 primer, or equal
 2. Finish coat (DFT = as needed), Sika Sikaflex 2c NS, BASF Masterseal NP-2, or equal
- T. IZEP – Inorganic Zinc/Epoxy/Polyurethane: The inorganic zinc primer shall be a water or solvent based, self-curing, zinc silicate two-component inorganic coating which contains at least 80% of metallic zinc by weight in the dried film and is recommended by the coating manufacturer as a primer for this system. The intermediate coat shall be a high-build two component epoxy with a solids content of at least 70% by volume. If the steel surface is UV-exposed, finish coats shall be a two-component aliphatic acrylic or polyester polyurethane coating material that provides superior color and gloss retention, resistance to chemical fumes and severe weathering, and a minimum solids content of 58% by volume.
1. Prime coat (DFT = 2 mil), Dimecote 9 VOC, Tnemec 90-97 Tneme-Zinc, Carbozinc 11 VOC or equal.

2. Intermediate coat (DFT = 4 mils), Amerlock 2, Carboline 890, Tnemec 104, or equal.
 3. If the surface is UV-exposed, finish coats (one or more, DFT = 3 mils), Amershield VOC, Carboline 133VOC, Tnemec Series 1075 Endura-Shield, or equal.
 4. Total system DFT = 9 mils. PE – Polyethylene Encasement for Ductile Iron Pipe: Application of polyethylene encasement shall be in accordance with ANSI/AWWA C105 using Method C.
- U. PT – Petrolatum Tape: Prior to wrapping the pipe with petrolatum tape, the pipe and fittings first shall be primed using a primer recommended by the petrolatum tape manufacturer. After being primed, the pipe shall be wrapped with a 20-mil adhesive petrolatum tape, half-lapped, to a total thickness of 40 mils. All wrapped coating shall be spark-tested per NACE SP0188 in the Presence of the Inspector. Approved products include the following:
1. Primer (DFT = 1 gal/100 sq. ft), Wax Tape Primer as manufactured by Trenton Corporation.
 2. Profiling Mastic (DFT as needed to provide smooth profile for the coating system), Fill-Pro PM-GP as manufactured by Trenton Corporation.
 3. Tape (DFT = 70 mils), #1 Wax Tape as manufactured by Trenton Corporation.
 4. Mechanical Protection Outer Wrap (DFT = 1.5 mils), Poly-Ply as manufactured by Trenton Corporation.
- V. PVC – Concrete Embedded PVC Liner: To be used to line cast-in-place or prefabricated concrete exposed to municipal wastewater. Approved products include
1. T-Lock as manufactured by Ameron International Protective Lining Products or approved equal.
 2. Thickness Required: 60 mils.
- W. P100 – 100% Solids Polyurethane – To be used to line the interior surfaces of steel pipe or concrete exposed to municipal wastewater, gas, and sludge. Approved products include Endura Flex 1988 as manufactured by Global Eco Technologies, Polibrid 705 as manufactured by Carboline Company.
1. Finish coat: 1 coat at 60 mils DFT.
- X. RMTR – Resurfacer for concrete walls or structures following the abrasive blasting shall be high early strength, epoxy-modified mortar with aggregates capable of producing a dry rough finished surface. The material shall be a two or three-component aggregate-filled mortar to be applied on vertical walls and overhead walls and capable of being topcoated within 24 hours of application. Approved products include the following:

1. Finish Coat (Thickness = Less than ½-inch or greater to produce an even surface), Sauereisen Restokrete Filler Compound 209, Themec Series 218 Mortar Clad, or approved equal.
 2. Total Thickness = ½-inch or greater as needed to produce an even surface.
- Y. SIL1000 - Aluminum Silicone Resin and Zinc-Rich Primer: Aluminum silicone resin material shall be suitable for a service temperature of up to 1,000°F and shall comply with Federal Specification TT-P-28. Zinc rich primer shall only be applied on non-immersion steel surfaces that are above or exposed to the wastewater surface.
1. Prime coat (DFT = 1.5 to 2 mils) – Thurmalox 245C, Thermaline 2977, or equal
 2. Finish coat (2 coats, DFT = 1.5 to 2 mils per coat) – Thurmalox 230C, Thermaline 4700 VOC, or equal.
 3. Total system DFT = 4.5 to 6 mils.
- Z. VAL1 – Powder coating for steel, cast iron, and ductile iron valves to be shop coated and lined. The powder coating shall be polyester or acrylic-based and shall resist a minimum of 1,000 hours of salt fog testing per ASTM B117 with blistering or rusting. Approved products include the following:
1. Finish Coat (DFT = 3 to 6 mils), Tiger Drylac Series 49, Bray Controls Nylon 11, or equal.
- AA. VE1 – Epoxy/Vinyl Ester Reinforced Flexible Lining-Concrete: A 100% solids vinyl ester primer, 100% solids epoxy silica reinforced basecoat, fiberglass mat reinforcement intermediate layer, and an epoxy or vinyl ester topcoat. The vinyl ester topcoat shall be used for ferric chloride, sodium hypochlorite, or citric acid exposure and the epoxy topcoat shall be used for the sodium bisulfate exposure. The entire system shall be suitable for immersion service in citric acid, sodium bisulfate and sodium hypochlorite solutions in secondary containment areas.
1. Prime coat (DFT=3 to 4 mils): Primer 67 as manufactured by Dudick Inc. or approved equal.
 2. Base coat with silica filler (DFT=25 sq. ft. per gallon): Protecto-Flex 800, Protecto-Flex 805, or Protecto-Flex 310 Basecoat as manufactured by Dudick Inc. or approved equal.
 3. Intermediate Reinforcing Mat: 1 ounce chopped fiberglass strand mat
 4. Intermediate Saturant Coat (DFT=60 sq. ft. per gallon): Protecto Flex 800, Protecto-Flex 805, or Protecto-Flex 310 Basecoat as manufactured by Dudick Inc. or approved equal.
 5. Topcoat (DFT=60 to 70 sq. ft. per gallon): Protecto Flex 800 Topcoat, Protecto Flex 805or Protecto-Flex 310 Topcoat as manufactured by Dudick Inc. or approved equal.
 6. Total System DFT: 100 to 110 mils

- BB. VE2 – Vinyl Ester or Epoxy Reinforced Lining-Concrete: A 100% solids vinyl ester or epoxy primer, 100% solids vinyl ester or epoxy graphite-reinforced basecoat, fiberglass mat reinforcement intermediate layer, aluminum oxide filled vinyl ester or epoxy topcoat, and aliphatic polyurethane finish coat. The vinyl ester basecoat/topcoat shall be used for sodium hypochlorite or citric acid exposure and the epoxy basecoat topcoat shall be used for the sodium bisulfate exposure. The entire system shall be suitable for accidental splashing or spilling of citric acid, sodium bisulfate and sodium hypochlorite solutions in chemical storage unloading areas with truck traffic and sun exposure.
1. Prime coat (DFT=3 to 4 mils): Primer 27 as manufactured by Dudick Inc. or approved equal.
 2. Base coat with graphite filler (DFT=25 sq. ft. per gallon): Protecto-Line 100, Protecto-Line 800, or Protecto-Line 805 with G-9 filler as manufactured by Dudick Inc. or approved equal.
 3. Intermediate Reinforcing Mat: 1 ounce chopped fiberglass strand mat
 4. Intermediate Saturant Coat (DFT=60 sq. ft. per gallon): Protecto Line 800, Protecto-Line 805, or Protecto-Line 100 Basecoat as manufactured by Dudick Inc. or approved equal
 5. Topcoat (DFT=60 to 70 sq. ft. per gallon): Protecto-Line 800, Protecto-Line 805 with G-9, Protecto-Line 100 with G-9 as manufactured by Dudick Inc. or approved equal.
 6. Finish coat (DFT=5 mils): Sealer 30 as manufactured by Dudick Inc. or approved equal.
 7. Total System DFT: 125 mils

PART 3 EXECUTION

3.1 ENVIRONMENTAL CONDITIONS

- A. No coating work shall be performed under the following conditions:
1. Surface or ambient temperatures exceed the manufacturer's recommended maximum or minimum allowable.
 2. Dust or smoke laden atmosphere.
 3. Damp or humid conditions, where the relative humidity is above the manufacturer's maximum allowable.
 4. Substrate and ambient temperatures are less than 5°F above the dewpoint and are decreasing. Dewpoint shall be measured by use of an instrument such as a Sling Psychrometer in conjunction with U.S. Department of Commerce, Weather Bureau psychrometric tables. Elcometer 319 Dew Point meter or equal may also be used.
 5. Ambient temperature that is expected to drop below 50°F or less than 5°F above the dewpoint within 8 hours after application of coating.

- B. If the WORK on the structure is subject to extended periods of low temperature or high humidity, the Contractor shall be expected to maintain the established production schedule despite these potentially adverse conditions by providing all labor, equipment, and materials necessary to maintain a controlled environment in the area where WORK is to be performed. The substrate and atmospheric conditions within the controlled environment, with respect to temperature and relative humidity, shall be maintained within the limits established by the manufacturer of the selected coating system to ensure proper application and cure of the coating. If the conditions are not in the specified ranges stated by the manufacturer, the Contractor shall use the following:
1. Humidity Control – Desiccant or Direct Expansion Refrigeration dehumidification will be used to control the environment in the space 24 hours a day during blast cleaning, coating application and coating cure. Equipment will conform to the following requirements:
 - a. Equipment – Desiccant dehumidifiers will be a solid desiccant design having a single rotary desiccant wheel capable of fully automatic continuous operation. No liquid, granular, or loose lithium chloride drying systems will be accepted. The use of direct expansion (DX) refrigeration type dehumidifiers with reheat may be considered if the expected ambient temperature will remain above 60°F. Heating the space changes relative humidity only and does not change the dew point temperature. Heat alone, therefore, is not a substitute for dehumidification, unless substrate temperature is high enough to meet the dew point differential. The dehumidification system may consist of a combination of desiccant and refrigerant equipment.
 - b. Air Changes – The air change rate for maintaining the required spread of 17°F between inside surface temperature and inside space dew point temperature with a maximum relative humidity of 45% in the space will depend upon the type of equipment to be used and the time of year during the application. There shall be 1 to 3 air changes per hour, depending on the air volume of the structure, to hold the desired degree of cleanliness of the surface.
 2. Temperature Control – Auxiliary cooling or insulation may be necessary to maintain the surface temperature at an acceptable level for the coating manufacturer's application parameters. This auxiliary equipment must be approved for use by the supplier of the dehumidification equipment and will meet the following requirements.
 - a. Refrigerant type systems must be installed in the process air supply duct between, and/or blended with, the dehumidifier as close to the work space as possible.
 - b. Only electric, indirect fired combustion, or steam coil auxiliary heaters will be used. No direct-fired space heaters will be allowed during the blasting, coating, or curing phases.
 - c. The space to be controlled will be sealed off as well as possible, allowing air to escape the work space away from the point where the dehumidified air is being introduced. If it is necessary to filter the air escaping the space, the filtration system must be designed so that it does not interfere with the dehumidification equipment's ability to control the dew point and relative humidity of the work space.

3.2 SURFACE PREPARATION OF METALLIC SURFACES

- A. The minimum surface preparation shall be as specified in the coating system schedules included at the end of this Section.
- B. The Shop Applicator shall remove all water, grease, dust, and other contaminants from the surfaces prior to centrifugal or manual abrasive blast cleaning. All oil, grease, welding fluxes and other surface contaminants shall be removed by solvent cleaning per SSPC SP1 prior to blast cleaning.
- C. All sharp edges and welds shall be rounded or chamfered and all burrs, surface defects, and weld spatter shall be ground smooth prior to abrasive blast cleaning. The power tool cleaning shall conform to SSPC SP3 and NACE RP0178.
- D. Abrasive Blast Cleaning – The type and size of abrasive shall be selected to produce a surface profile that meets the coating manufacturer's recommendation for the particular coating and service conditions.
- E. The Field Applicator shall not reuse abrasive blasting media unless otherwise approved by the INSPECTOR.
- F. Compressed air for air blast cleaning shall be supplied at adequate pressure from well maintained compressors equipped with oil/moisture separators which remove at least 95% of the contaminants. If necessary, the INSPECTOR shall conduct oil and water tests per ASTM D4285.
- G. For every 100 square feet of steel that is blasted, the surface profile shall be tested with the use of Press-o-Film as manufactured by Testex, or other RP0287 approved equal, at locations to be determined by the INSPECTOR. For every 100 square feet of steel pipe blasted, the surface profile shall be tested at locations determined by the INSPECTOR. The replica tape thickness shall be measured using a dial micrometer manufactured by Testex, or other ASTM D4417 Type C approved equal. For each test area, one replica tape test shall be performed within a single test area 12 inches in diameter. For each test area, the replica tape thickness values shall be recorded and must be within 10% of the coating manufacturer's recommended profile.
- H. Metal surfaces less than 25 square feet which are to be incorporated in the work shall be prepared in the field by cleaning all surfaces as necessary in accordance with SSPC SP1, SP2, and SP11. Damaged shop coating shall be cleaned in accordance with SSPC SP11 using an MBX Bristleblaster, or equivalent, and recoated with the primer specified.
- I. The Field Coating Applicator shall not apply a coating on a bare steel surface that is to be immersed and has not been prepared to an SSPC SP10 surface profile. Special attention shall be given to uncoated steel weld joints, coating holdbacks, and bare metal.
- J. The CONTRACTOR shall verify the wet film thickness with a notched gauge in conformance with ASTM D4414. Wet film thickness readings shall be recorded a minimum of every 100 square feet.
- K. Surfaces shall be cleaned of all dust and residual particles by dry air blast cleaning, vacuuming, or other approved methods, prior to coating.

- L. Enclosed areas and other areas where dust settling is a problem shall be vacuum cleaned and wiped with a tack cloth to prevent contamination of previously cleaned surfaces.
- M. The Field Applicator shall not apply a coating on a bare steel surface for non-immersion service that has not been prepared to per SSPC SP6. Special attention shall be given to uncoated steel weld joints, coating holdbacks, and bare metal.

3.3 SURFACE PREPARATION CONCRETE

- A. All loose, brown, white, carbonated, deteriorated, or unsound concrete shall be removed in the immediate vicinity of the documented damaged areas to provide a termination point that is tightly adhered to the concrete surfaces. The CONTRACTOR shall use high pressure water jetting per SSPC WJ-4 at a minimum pressure of 5,000 psi.
- B. Concrete surfaces shall be abrasive blasted per SSPC SP13 to remove the top 0.125 inches of brown, white, loose concrete and to produce a surface roughness equivalent to that of ICRI 310.2 Concrete Surface Profile 5. The depth of concrete to be removed shall be measured by pre-drilling holes 0.125 inch deep, 5 feet by 5 feet apart, before any surface preparation occurs. The removal of sufficient concrete shall be measured by comparing the surrounding concrete to the predrilled holes. If grease or other contaminants remain on the surface, the CONTRACTOR shall scrub the surfaces with a mixture of trisodium phosphate detergent and water until the surfaces are acceptable to the INSPECTOR.
- C. Mock-Up: Before the start of the coating application, the CONTRACTOR shall perform a sample test patch (mock-up) of the surface preparation and complete coating application on an area equivalent to 25 square feet. The location of the test patch shall be pre-approved by the Coating Inspector or DISTRICT for approval prior to commencing work.
- D. Install a 1/4-inch wide by 1/4-inch deep groove in the concrete near all coating termination points such as at the bottom of a wall/column or around a pipe penetration. Dust, debris, and other contaminants shall be removed prior to primer application.
- E. In accordance with ASTM D4262, test to determine the pH of the concrete surface after the surface has been thoroughly blasted and cleaned. If the pH is outside the range recommended by the coating manufacturer, then the surface must be neutralized by removing concrete until a surface pH of 8 is obtained. One pH test shall be performed every 100 square feet, or less, and at locations determined by the INSPECTOR.
- F. The CONTRACTOR shall test for capillary moisture in accordance with ASTM D4263. Moisture tests shall be taken every 50 square feet or less and at locations determined by the INSPECTOR. If capillary moisture is present, the coating manufacturer shall be consulted to determine primer requirements and special coating application criteria.
- G. For enclosed structures with horizontal surface areas greater than 500 square feet, the CONTRACTOR shall install three anhydrous calcium chloride test kits on bare concrete to measure the Moisture Vapor Transmission Rate (MVTR) on a flat horizontal surface. Testing and calculations shall be performed according to ASTM F1869. The test kits shall be undisturbed for a minimum of 60 hours. The MVTR shall be less than 3 lbs per 1,000 square feet per 24 hours. If the MVTR is greater than 3 lbs per 1,000 square feet per 24 hours, the CONTRACTOR shall apply a concrete sealant

to reduce the MVTR through the concrete or install environmental control equipment to dry the concrete for a minimum of 4 hours.

- H. The CONTRACTOR shall use Coating System RMTR to resurface the existing concrete following abrasive blasting on areas that are greater than 1/8-inch in depth or 1/8-inch in width. The existing concrete shall be resurfaced with a high early strength, epoxy-modified cement resurfacer, as specified, prior to the installation of the epoxy primer. The resurfaced concrete shall be finished with a masonry brush with 4-inch long Tampico fibers, completely cured, and dried according to the manufacturer's recommendations.
- I. After curing, and prior to coating, the resurfaced concrete shall receive a light abrasive blast per SSPC SP7 to produce a surface roughness equivalent to that of ICRI 310.2 Concrete Surface Profile 3.

3.4 SURFACE PREPARATION FOR ALUMINUM AND GALVANIZED METAL

- A. Galvanized ferrous metal shall be alkaline cleaned per SSPC-SP1 to remove oil, grease, and other contaminants detrimental to adhesion of the protective coating system to be used.
- B. Any high spots, sharp protrusions, and rough edges, such as the metal drip line, shall be smoothed to avoid paint film gaps in the areas of the high spots. Surfaces shall be hand tool cleaned per SSPC SP2 and power tool cleaned per SSPC SP3.
- C. Pretreatment coatings of surfaces shall be in accordance with the printed recommendations of the coating manufacturer. Galvanized metals may be cleaned with suitable organic solvent such as a rust inhibitor or aqueous alkaline solution per ASTM D6386.
- D. Aluminum surfaces shall be cleaned per ASTM D1730 Type B Chemical Treatment prior to coating application.
- E. The surfaces of the aluminum or galvanizing shall be abrasive blasted per SP16 prior to coating. A minimum 1.5 mil profile shall be produced and cleaned prior to the application of a protective coating.

3.5 SURFACE PREPARATION – FERROUS METALS

- A. The Shop Painting Facility shall use a minimum blast material mixture of 75% grit and 25% shot material to achieve the proper surface profile.
- B. The Field Coating Applicator shall abrasive blast the shop coated surfaces per SSPC SP7. The previously shop-painted surfaces shall be abraded prior to the application of the final coats. Special attention shall be given to uncoated steel weld joints, coating holdbacks, and bare metal.
- C. Grease, oil, and welding fluxes shall be removed by wiping with MEK or naphtha cleaning or with trisodium phosphate detergent per SSPC SP1.
- D. All sharp edges shall be rounded or chamfered and all burrs, rust, scale, welding slag, and spatter shall be removed and the surface prepared by SSPC SP2 hand tool cleaning, and SSPC SP3 power tool cleaning.

- E. The Contractor shall test the surfaces exposed to the marine atmosphere for soluble salts with the use of Chlor*Test as manufactured by Chlor*Rid International or approved equivalent. Any blasted surfaces shall be tested and shall have a maximum concentration of 5 micrograms per square centimeter ($\mu\text{g}/\text{cm}^2$). A test shall be conducted for every 100 square feet (ft^2) of surface area to be coated at locations determined by the Inspector.
- F. If the soluble salt test indicates chloride concentrations greater than those outlined in these Specifications, the Contractor shall use Chlor*Rid, as manufactured by Chlor*Rid International, in the water source during Water Cleaning to remove the salts from the substrate. A substrate's surface preparation will be accepted once the soluble salt concentration is below the amounts outlined in these Specifications.
- G. The type and size of abrasive shall be selected to produce a surface profile that meets the coating manufacturer's recommendation for the particular coating and service conditions.
- H. The minimum abrasive blasting standard shall be as specified in the coating system schedules included at the end of this section. Where there is a conflict between these specifications and the coating manufacturer's printed recommendations for the intended service, a higher degree of cleaning shall apply.
- I. The abrasive shall not be reused unless otherwise approved by the Inspector. For automated shop blasting systems, clean oil-free abrasives shall be maintained.
- J. The Contractor shall comply with South Coast Air Quality Management Order for field abrasive blasting.
- K. Compressed air for air blast cleaning shall be supplied at adequate pressure from well maintained compressors equipped with oil/moisture separators which remove at least 95% of the contaminants. The Inspector shall conduct a blotter test to confirm the cleanliness of the air stream per ASTM D4285.
- L. Blast cleaned steel surfaces shall meet the manufacturer's recommended surface profile as tested using replica tape per NACE RP0287. The Inspector shall perform the surface profile tests on all bare steel as outlined in 3.10G.
- M. Surfaces shall be cleaned of all dust and residual particles of the cleaning operation by dry air blast cleaning, vacuuming or another approved method prior to painting.
- N. Enclosed areas and other areas where dust settling is a problem shall be vacuum cleaned and wiped with a tack cloth.
- O. Damaged or defective coating shall be removed by the specified blast cleaning method to meet the clean surface requirements before recoating.
- P. If the specified abrasive blast cleaning will damage adjacent work, the area to be cleaned is less than 100 square feet, and the coated surface will not be submerged in service, then SSPC-SP2, hand tool cleaning or SSPC-SP3, power tool cleaning, may be used.
- Q. Shop applied coatings of unknown composition shall be completely removed before the specified coatings are applied. Valves, castings, ductile or cast iron pipe, and

fabricated pipe or equipment shall be examined for the presence of shop-applied temporary coatings.

- R. Clarifier Steel: The Shop Painting Facility shall use a minimum blast material mixture of 75% grit and 25% shot material, or similar mixture, to achieve the specified surface profile.
- S. Clarifier Steel: The Shop Painting Facility shall abrasive blast the steel per SSPC SP10 on all non-immersed and immersed steel.
- T. Clarifier Steel: The Field Coating Applicator shall abrasive blast the metallic surfaces of the sludge collector arms, launder supports, turbine, center column, rake drive, and baffles and other attached metallic appurtenances, to achieve an SSPC SP7 surface profile.

3.6 SHOP COATING REQUIREMENTS

- A. Shop Priming of Ferrous Metals: Surfaces to be field sandblasted for coal tar epoxy coatings shall have no shop painting. Galvanized surfaces shall have no shop priming. All other ferrous surfaces to be field painted shall have a shop coat of primer. If shop primer is not compatible with the field paint, then said shop primer shall be removed by sandblasting and the surface shall be primed with specified primer.
- B. Shop primed surfaces which are to be incorporated in the work shall be prepared in the field by cleaning all surfaces as necessary in accordance with SSPC SP1 and SP2. Damaged shop coating shall be cleaned in accordance with SSPC SP3, Power Tool Cleaning, and recoated with the primer specified.
- C. For every 500 square feet, or less, of steel surface blasted, the surface profile shall be tested with the use of Press-o-Film as manufactured by Testex, or other RP0287 approved equal, at locations to be determined by the Inspector. The replica tape thickness shall be measured using a dial micrometer manufactured by Testex, or other ASTM D4417 Type C approved equal. For each test area, one replica tape test shall be performed. For each test area, the three replica tape thickness values shall be recorded and must be within 10% of the coating manufacturer's recommended profile. If the surface profile does not meet the manufacturer's recommended profile, two additional tests will be performed within a 12-inch diameter of the initial test. If the values are not satisfactory, the Contractor shall reblast the affected areas.
- D. All items of equipment, or parts of equipment which are not submerged in service, shall be shop primed and then finish coated in the field after installation with the specified or approved color. The methods, materials, application equipment and all other details of shop painting shall comply with this section. If the shop primer requires top coating within a specified period of time, the equipment shall be finish coated in the shop and then touch-up painted after installation.
- E. All items of equipment, or parts and surfaces of equipment which are submerged or inside an enclosed hydraulic structure when in service, with the exception of pumps and valves, shall have all surface preparation and coating work performed in the field.
- F. For certain pieces of equipment it may be undesirable or impractical to apply finish coatings in the field. Such equipment may include engine generator sets, electrical control panels, switchgear or main control boards, submerged parts of pumps, ferrous metal passages in valves, or other items where it is not possible to obtain the specified

quality in the field. Such equipment shall be shop primed and finish coated and touched up in the field with the identical material after installation. The Contractor shall require the manufacturer of each such piece of equipment to certify as part of its shop drawings that the surface preparation is in accordance with these Specifications. The coating material data sheet shall be submitted with the shop drawings for the equipment.

3.7 FACTORY-PAINTED EQUIPMENT

- A. Except as otherwise noted in the Painting Schedule or specified, the following items of equipment shall receive final finish coats at the factory. Factory-painted items shall be of a color specified, selected, or accepted by the Owner.
 - 1. Chemical feeders (parts specified to have baked enamel finish)
 - 2. Chlorinators
 - 3. Cranes and hoists
 - 4. Electric switchgear and motor control centers
 - 5. Gauges and meters
 - 6. Instrument and control panels
 - 7. Instruments
 - 8. Light fixtures
 - 9. Meter panels
 - 10. Transformers
 - 11. Transmitters
- B. For certain small pieces of equipment the manufacturer may have a standard coating system which is suitable for the intended service conditions. In such cases, the final determination of suitability will be made during review of the shop drawing submittals. Equipment of this type generally includes only indoor equipment such as instruments, small compressors, and chemical metering pumps.
- C. Shop painted surfaces shall be protected during shipment and handling by suitable provisions including padding, blocking, and the use of canvas or nylon slings. Primed surfaces shall not be exposed to the weather for more than 6 months before topcoated, or less time if recommended by the coating manufacturer.
- D. Damage to shop-applied coatings shall be repaired in accordance with this section and the coating manufacturer's printed instructions.
- E. The Contractor shall make certain that the shop primers and field topcoats are compatible and meet the requirements of this section. Copies of applicable coating manufacturer's data sheets shall be submitted with equipment shop drawings.

3.8 SPRAY APPLIED COATING APPLICATION

- A. General: No exterior or interior painting shall be done under conditions which, in the opinion of the Inspector, could jeopardize the appearance or quality of the finish in any way. It may be necessary for the Contractor to provide a working area which is protected, heated, and has a controlled atmosphere.
- B. Plural Component Coatings – Only heated plural component equipment shall be used for the 100% solids coating application. Equipment shall be capable of performing a ratio test. All gauges on plural component pump shall be in working order. If defective, they shall be replaced prior to the start of any application.
- C. Plural Component Coatings – After each component of the plural component coating system has been thoroughly heated, the CONTRACTOR shall perform a paint pump ratio test on the first day of spraying and at least once a day thereafter in the presence of the Inspector. The CONTRACTOR shall place two see-through containers with preprinted volumetric marks on a flat surface. The hose valve for each component shall be opened simultaneously and each component flow rate shall be allowed to stabilize by pouring the discharging materials into separate disposable containers. After the flow is stabilized, the hoses shall be transferred to the pre-printed volumetric containers and the valves shall be shut off after one of the containers has been filled to 32 or 48 fluid ounces, depending on the mixing ratio recommended by the manufacturer. If the volumetric quantity of coating in the containers does not match the manufacturer's recommendation, the CONTRACTOR shall reduce or increase the pressure and temperature until it meets the specified mixing ratio. No spraying shall be performed until the ratio test result has been accepted by the INSPECTOR.
- D. Cleaned surfaces and all coats shall be inspected prior to each succeeding coat. The CONTRACTOR shall schedule such inspection with the INSPECTOR 24 hours in advance.
- E. An independent stripe coat shall be applied to structural steel flange edges, angles, crevices, weld seams, nuts and bolts, and other places where insufficient film thicknesses are likely to be present. Particular care shall be used to ensure that the specified coverage is applied on the edges and corners of all surfaces.
- F. For metal surfaces to be submerged in water, the Field Coating Applicator shall not apply a coating on a bare steel surface that has not been prepared according to SSPC SP10 or a primed surface that has not been prepared according to SSPC SP7.
- G. The application of protective coatings to steel substrates shall be in accordance with "Paint Specification No. 1, (SSPC PA 1)", Steel Structures Painting Council.
- H. Cleaned surfaces and all coats shall be inspected prior to each succeeding coat. The Contractor shall schedule such inspection with the Inspector in advance.
- I. Blast cleaned ferrous metal surfaces shall be painted before any rusting or other deterioration of the surface occurs. Blast cleaning shall be limited to only those surfaces that can be coated in the same working week.
- J. Coatings shall be applied in accordance with the manufacturer's instructions and recommendations, and this section, whichever has the most stringent requirements.

- K. Special attention shall be given to edges, angles, weld seams, flanges, nuts and bolts, and other places where insufficient film thicknesses are likely to be present. Use stripe painting for these areas. Particular care shall be used to ensure that the specified coverage is secured on the edges and corners of all surfaces.
- L. Special attention shall be given to materials which will be joined so closely that proper surface preparation and application are not possible. Such contact surfaces shall be coated prior to assembly or installation.
- M. Finish coats, including touch-up and damage repair coats shall be applied in a manner which will present a uniform texture and color matched appearance.
- N. Steel piping shall be abrasive blast cleaned and primed before installation.
- O. Clarifier Steel: The previously shop-painted surfaces shall be abraded per SSPC SP7 after the clarifier has been erected and prior to the application of the final coats. Special attention shall be given to uncoated steel weld joints, coating holdbacks, bare metal, and areas of mechanical damage due to the installation of fasteners.
- P. Clarifier Steel: The Field Coating Applicator shall not apply a final coating on a bare steel surface that has not been prepared to an SSPC SP10 surface profile or a primed surface that has not been prepared to an SSPC SP7 surface profile.
- Q. Clarifier Steel: If stainless steel fasteners are installed, they shall be abrasive blasted per SSPC SP7 prior to the application of the final coat.

3.9 CURING OF COATINGS

- A. If necessary, the Inspector shall conduct a Solvent Rub Test in accordance with ASTM D5402 after 8 hours of curing. The test area shall be evaluated for appearance, hardness, or any color transfer to the cloth. If there is no change to the coating after the test, it will be considered cured.
- B. If necessary, the Inspector shall conduct Shore D Hardness Testing in accordance with ASTM D2240. In order to consider the coating cured and properly mixed, it must meet the manufacturer's recommended Shore D Durometer requirement for the specified product.
- C. The Contractor shall provide curing conditions in accordance with the conditions recommended by the coating material manufacturer or by this section, whichever is the most stringent requirement, prior to placing the completed coating system into service.
- D. In the case of enclosed areas, forced air ventilation, using heated air, if necessary, may be required until the coatings have fully cured.

3.10 TESTING AND INSPECTION DURING AND AFTER APPLICATION

- A. The field and shop Contractor's QA/QC person and the Owner's Inspector shall provide anchor profile measurements, blast hose pressures, type/percent mixture of the abrasive, and shall check the compressor air cleanliness.
- B. The field and shop Contractor's QA/QC person and the Owner's Inspector shall provide a written record of the quantity of coating material applied and the corresponding surface area covered, a description of the area coated, each coating product batch

number, dew point temperature, surface temperature, ambient temperature, relative humidity, and names of applicators on a daily basis.

- C. The field and shop Contractor's QA/QC person and the Owner's Inspector shall provide wet film and dry film thickness readings, results of the holiday testing, and shall note any discrepancies with the coating specifications.
- D. Inspection Devices: The Contractor shall furnish, until final acceptance of such coatings, inspection devices in good working condition for the detection of holidays and measurement of dry-film thicknesses of protective coatings. Dry-film thickness gages shall be made available for the Inspector's use at all times while coating is being done, until final acceptance of such coatings. The Contractor shall provide the services of a trained operator of the holiday detection devices until the final acceptance of such coatings.
- E. Holiday Testing: The Contractor shall holiday test all coated ferrous surfaces, or other surfaces which will be submerged in water or other liquids, or concrete surfaces which are enclosed in a vapor space in such structures and surfaces coated with any of the submerged and severe service coating systems in the presence of the Inspector. Areas which contain holidays shall be marked and repaired or recoated and retested in accordance with the coating manufacturer's printed instructions.
 - 1. Coatings With Thickness Exceeding 20 Mils: For surfaces having a total dry film coating thickness exceeding 20 mils: pulse-type holiday detector such as Tinker & Rasor Model AP-W, D.E. Stearns Co. Model 14/20, or equal shall be used. Holiday testing shall be conducted with a new 12-inch or 18-inch wide wire brush electrode attached to the unit. A silicon rubber electrode shall not be allowed. The unit shall be adjusted to operate at the voltage required to cause a spark jump across an air gap equal to twice the specified coating thickness.
 - 2. Coatings With Thickness of 20 Mils or Less: For surfaces having a total dry film coating thickness of 20 mils or less: Tinker & Rasor Model M1 non-destructive type holiday detector, K-D Bird Dog, or equal shall be used. The unit shall operate at less than 75 volts. For thicknesses between 10 and 20 mils, a non-sudsing type wetting agent, such as Kodak Photo-Flo, or equal, shall be added to the water prior to wetting the detector sponge.
- F. Film Thickness Testing: On ferrous metals, the dry film coating thickness shall be measured in accordance with the SSPC "Paint Application Specification No. 2" using a magnetic-type dry film thickness gage. The instruments shall have the capability of measuring 50% over the specified coating thickness and shall produce an actual reading and shall not be estimated. No measurements shall be made until at least 8 hours after application of the coating. The following instruments are acceptable:
 - 1. Concrete Surfaces
 - a. Wet – Notched gauge per ASTM D4414, or approved equal
 - b. Dry – PosiTector 200, or approved equal
 - 2. Ferrous and Non Ferrous Surfaces
 - a. Wet – Notched gauge per ASTM 4414, or approved equal
 - b. Dry – Elcometer Model 456, PosiTector 6000, or equal

- G. Steel Surface Preparation Profile: For every 500 square feet or less of steel surface blasted, as determined by the Inspector, the surface profile shall be tested with the use of Press-o-Film as manufactured by Testex, or other RP0287 approved equal, at locations to be determined by the Inspector. The replica tape thickness shall be measured using a dial micrometer manufactured by Testex, or other ASTM D4417 Type C approved equal. For each test area, one replica tape test shall be performed within a single test area 12 inches in diameter. For each test area, the three replica tape thickness values shall be recorded and must be within 10% of the coating manufacturer's recommended profile. If the surface profile does not meet the manufacturer's recommended profile, two additional tests will be performed within a 12-inch diameter of the initial test. If the values are not satisfactory, the Contractor shall reblast the affected areas.
- H. Concrete Coating Adhesion Testing – For every 500 square feet of coating material applied, or fraction thereof, the coating adhesion to the concrete substrate shall be tested per ASTM D 4541 using Type II or Type V instruments, Elcometer 106 or Defelsko Positest ATM or equal, by the Inspector. The procedure is as follows:
1. A minimum of one 20-mm diameter dolly shall be affixed to the coated surface within the structure for every 200 square feet or more, as mutually agreed by the Owner and the Contractor. Each testing location shall be identified and recorded by the Inspector.
 2. Prior to conducting the pull-off test, the Inspector shall score around the dolly without disturbing the dolly or bond within the test area. The scoring shall penetrate through the newly applied coating and abrade the substrate.
 3. The adhesive used to attach the dollies to the liner shall be rapid setting with a tensile strength in excess of the coating material and permitted to cure in accordance with the manufacturer's recommendations. The lining material and dollies shall be adequately prepared to receive the adhesive. Failure of the dolly adhesive shall require re-testing.
 4. The adhesion pulls shall exceed 200 psi with concrete failure with more than 50% of the subsurface adhered to the coating. Pull tests with results between a minimum 150 psi and 200 psi shall be acceptable if more than 50% of the subsurface is adhered to the back of the dolly. If two dollies do not meet the adhesion requirements, an additional location shall be tested on the same surface. If 60% of the adhesion tests fail to meet the adhesion requirements, the liner shall be removed and replaced at the Contractor's expense.
 5. The Inspector shall record the type of adhesive used, the length of time the adhesive was allowed to cure, and the type of failure observed on the dolly.
 6. The CONTRACTOR shall repair the coating or lining at the locations of the adhesion tests per the manufacturer's recommendations. The testing dollies shall be retained by the Coating Inspector at the conclusion of the testing.

3.11 WARRANTY INSPECTION

- A. The Contractor and coating manufacturers shall warrant the coating system applications against defects and workmanship after final acceptance of the Work for a period of 2 years. The Contractor shall perform all Work and supply all equipment and

materials associated with the repair of failures identified in the warranty inspection at no cost to the Owner.

- B. A warranty inspection may be conducted prior to expiration of the 2 year warranty period after final acceptance of all coating work. The Contractor and a representative of the coating material manufacturer shall attend this inspection at no cost to the Owner. All defective work shall be repaired in accordance with these specifications and to the satisfaction of the Owner. The Owner may by written notice to the Contractor, reschedule the warranty inspection, or may cancel the warranty inspection altogether. If a warranty inspection is not held, the Contractor is not relieved of its responsibilities under the Contract Documents.
- C. A total of two (2) inspections will be required at locations chosen by the Owner and can include any or all surfaces. The Owner will be responsible for dewatering and providing access, and for performing the inspection and testing. The inspection will include thorough visual inspection to identify pin holes, delaminations or other product or installation defects. The Owner, at its sole discretion, may choose to perform bond strength testing per ASTM D4541. The Contractor shall conduct repairs to coated surface per the manufacturer's recommendations and the repaired surfaces shall be subject to inspection by the Owner.

3.12 CURING OF COATINGS

- A. If necessary, the Inspector shall conduct a Solvent Rub Test in accordance with ASTM D5402 after 8 hours of curing. The test area shall be evaluated for appearance, hardness, or any color transfer to the cloth. If there is no change to the coating after the test, it will be considered cured.
- B. If necessary, the Inspector shall conduct Shore D Hardness Testing in accordance with ASTM D2240. In order to consider the coating cured and properly mixed, it must meet the manufacturer's recommended Shore D Durometer requirement for the specified product.
- C. The Contractor shall provide curing conditions in accordance with the conditions recommended by the coating material manufacturer or by this section, whichever is the most stringent requirement, prior to placing the completed coating system into service.
- D. In the case of enclosed areas, forced air ventilation, using heated air, if necessary, may be required until the coatings have fully cured.
- E. The contractor shall provide a letter to the Owner, prior to disinfection, stating that the coatings are fully cured and ready to be placed into service.

3.13 COATING SCHEDULE

Facility		Structure type - material	Lining System	Coating System	Surface Preparation
PVC or HDPE pipe		PVC and HDPE	N/A	E1	SP2
Headworks		Concrete	N/A	P100	SP13 abrasive blast and ICRI 310.2 Concrete Surface Profile 4 to 5. ** Applies to areas impacted by demolition and reconstruction within headworks. Contractor to submit =for review proposed transition between existing PVC liner (T-Lock) and new P100 coating system.
South Primary Clarifier		Immersed Steel	E1 and E2	N/A	SP10 with the 2 mil profile
		Non-Immersed Steel	N/A	EAP	SP10 with the 2 mil profile
		Concrete	RMTR and P100 at 125 mils DFT, unless otherwise approved at thinner coating.	N/A	SP13 abrasive blast and ICRI 310.2 Concrete Surface Profile 4 to 5
Miscellaneous Ferrous	Above Grade	Steel, cast iron, ductile iron	E1, FBE or VAL1	Sun Exposure – EAP Indoors = E2, FBE or VAL1	Interior – SP10 with the 2 mil profile Exterior – SP6 with the 2 mil profile
	Buried		E1, FBE or VAL1	Shop = E1, FBE, or VAL1 Field = PT	Interior – SP10 with the 2 mil profile Exterior – SP6 with the 2 mil profile
	Headspace Above Waste		E1, FBE or VAL1	E1, FBE or VAL1	Interior – SP10 with the 2 mil profile

Facility		Structure type material	Lining System	Coating System	Surface Preparation
	Water				Exterior – SP6 with the 2 mil profile
	Immersed		E1, FBE or VAL1	E1, FBE or VAL1	Interior – SP10 with the 2 mil profile Exterior – SP6 with the 2 mil profile
Miscellaneous Non-Ferrous	Above Grade	304SS, galvanized, aluminum, copper, PVC	E1, FBE or VAL1	Sun Exposure – EAP Indoors = E2, FBE or VAL1	SSPC SP2, SP3, SP16, or SP11
	Headspace Above Waste Water	304SS, galvanized, aluminum, copper	E1, FBE or VAL1	E2, FBE or VAL1	SSPC SP2, SP3, SP16, or SP11
	Immersed	304SS, galvanized, aluminum, copper	E1, FBE or VAL1	E2, FBE or VAL1	SSPC SP2, SP3, SP16, or SP11
Ductile Iron Pipe –above ground –below ground		Ductile Iron	Dia 18 inches or less = DIP1 or DIP2 (low solids) Dia 18 inches or less = DIP 3 (sludge)	EAP (sun exp) E2 (no sun exp and non-immersed)	Interior – SP10 with the 2 mil profile Exterior – SP6 with the 2 mil profile
Foul Air Ducting		FRP	None	EAP (sub exposure) E2 (no sun exposure)	Exterior SP2 and SP 3

END OF SECTION

SECTION 10400 – IDENTIFYING DEVICES

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall provide signs and other identifying devices and all appurtenant work, complete and in place, in accordance with the Contract Documents.
- B. Identifying devices required by other Section of the Specifications shall also comply with this Section.

1.2 CONTRACTOR SUBMITTALS

- A. General: The CONTRACTOR shall furnish submittals in accordance with the requirements of Section 01330 – Submittal Procedures.
- B. Shop Drawings: Full-size or scaled layouts of signs showing sign size, color, fasteners and mounting, and location. A typical of repetitive sign layouts may be submitted. Most restrictive conditions shall be depicted.
- C. Samples: Samples of all the materials and colors proposed for the Work, clearly marked to show the manufacturer's name and product identification along with the manufacturer's technical data and application instructions.

PART 2 PRODUCTS

2.1 GENERAL

- A. Identification devices shall be installed where directed by the ENGINEER. All wording shall be as indicated and shall be verified before fabrication.

2.2 BUILDING/ROOM NAMEPLATES

- A. Nameplates shall be Builders Brass Works, Vornar Products, Inc., or equal, with colored 1/8-inch acrylic plastic (matte finish). Lettering shall be white, 1/2-inch high, or 36 points, and shall be fused by heat and pressure to a depth of approximately 0.005-inch. Plates shall be installed in an extruded aluminum frame, medium bronze or dark anodized finish, and be provided with 2-way adhesive mounting tape. Plastic color and letter style shall be as selected by the ENGINEER. Provide and install a total of 15 nameplates to be defined and selected by the ENGINEER.

2.3 EQUIPMENT, TANKS, VALVE, AND GATE IDENTIFICATION

- A. All equipment, tanks, valves, and gate with P&ID tag numbers and names shall be installed with labels (after finish painting). The label shall include the P&ID tag and the common name (e.g. Filter Feed Pump). Identification of shall be provided by application of labels of adhesive-backed vinyl cloth. Adhesive will be recommended by the manufacturer for application to the specified coating systems.

1. Each equipment, tank, valve, or gate shall have a preprinted label to identify the item.
2. Letter sizes shall be 1 inch for equipment and gates, 2 inches for tanks, 1/2 inch for valves and small equipment.

2.4 SIGNS

- A. General: Signs or warning shall be enamel painted on semi-rigid butyrate. Signs shall conform to OSHA Standards and directions. Lettering sizes shall be 3-inch in height unless indicated otherwise herein.
- B. The following signs shall be furnished for installation where directed by the ENGINEER:

Sign	Quantity
EXIT	2
DANGER PERMIT REQUIRED CONFINED SPACE	4
CAUTION NON-POTABLE WATER DO NOT DRINK	10
WARNING THIS EQUIPMENT STARTS AUTOMATICALLY	3

2.5 LETTERS

- A. Metal: Letters shall be 3-inch anodic finish aluminum of medium bronze. Letters shall be provided complete with fasteners for concrete wall installation at the locations identified by the CONSTRUCTION MANAGER. Letters shall be provided for the following process areas (label to be verified with Owner):

1. SOUTH PRIMARY CLARIFIER

- B. Plastic: Plastic Letter shall be 3-inch Helvetica Medium lower case cut from 1/4-inch thick acrylic plastic, finished with auto paint coating of color selected by Owner.

2.6 MATERIALS

- A. Equipment Nameplates: Engraved or stamped and fastened to the equipment in an accessible location with No.4 or larger oval-head stainless steel screws or drive pins.
- B. Plastic Tags and Plates: Laminated three-layer plastic with engraved black letters on light contrasting background color.

- C. Metal Tags: Brass with stamped letters, tag size minimum 1-1/2 inch in diameter with finished edges
 - D. Stencils: With clean cut symbols and letters of following size:
 - 1. Up to 2 inches outside diameter of insulation or pipe: 1/2-inch-high letters.
 - 2. 2-1/2 to 6 inches outside diameter of insulation or pipe: 1-inch-high letters.
- 2.7 MANUFACTURERS:
- A. Craftmark Identification Systems
 - B. Safety Sign Co.
 - C. Seton Industrial Products

PART 3 EXECUTION

3.1 GENERAL

- A. All installation of identifying devices shall be vandal-resistant. Fasteners shall be concealed, non-corrosive fasteners appropriate for materials being fastened and as required.

3.2 INSTALLATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.
- B. Install in accordance with the MANUFACTURER's printed instructions.
- C. Install identifying devices after completion of coverings and painting.
- D. Install plastic nameplates with corrosive-resistant mechanical fasteners or adhesive.
- E. Install labels with sufficient adhesive for permanent adhesion, and seal with clear lacquer. For unfinished canvas covering, apply paint primer before applying labels.
- F. Install tags using corrosion-resistant chain. Number tags consecutively by location.
- G. Identify generator set with plastic nameplate. Identify in-line pumps and other small devices with tags.
- H. Identify control panels and major control components outside panels with plastic nameplates.
- I. Identify valves in main and branch piping with tags.
- J. Tag automatic controls, instruments, and relays.

3.3 LETTERS

- A. Installation of metal letters shall be 3/4-inch projection mounted from concrete block wall surface with threaded studs and space collars. The center of each row shall align. Letters shall be installed per MANUFACTURER's published instructions.

END OF SECTION

SECTION 11000 – EQUIPMENT GENERAL PROVISIONS

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall provide all tools, supplies, materials, equipment, and all labor necessary for the furnishing, construction, installation, testing, and operation of all equipment and appurtenant work, complete and operable, all in accordance with the requirements of the Contract Documents.
- B. The provisions of this Section shall apply to all equipment specified and where referred to, except where otherwise specified or shown.
- C. Package System Conduit Coordination: The package equipment vendors shall be responsible for coordination of field conduit and wiring. The vendors shall review the electrical drawings prior to bid and identify field conduit and wire that is required for the respective equipment package. If the field conduit and wire required to install the vendors package is not specifically shown on the electrical drawings, the vendor shall be responsible for providing and installing the necessary additional field conduit and wiring. The conduit, fittings, and boxes supplied by the vendor shall meet the code requirements for the area hazard classification defined in the electrical design documents.
- D. Package System Mechanical and Structural Coordination: The package equipment vendors shall be responsible for coordinating all structural attachments and supports and all mechanical and piping connections to the existing facilities. Structural anchorage shall be designed by the vendor and submitted for review and approval by the District. Vendor shall review all proposed points of connection for condition and configuration and incorporate field observations into the package system submittals.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Codes: All work specified herein shall conform to the requirements of all applicable codes and regulations.
- B. Commercial Standards: All equipment, products, and their installation shall be in accordance with the following standards, as applicable, and as specified in each Section of these specifications:
 - 1. ASTM International (ASTM).
 - 2. American Public Health Association (APHA).
 - 3. American National Standards Institute (ANSI)
 - 4. American Society of Mechanical Engineers (ASME).
 - 5. American Water Works Association (AWWA).

6. American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE).
7. American Welding Society (AWS).
8. National Fire Protection Association (NFPA).
9. Federal Specifications (FS).
10. National Electrical Manufacturers Association (NEMA).
11. Manufacturer's published recommendations and specifications.
12. General Industry Safety Orders (OSHA).
13. American Petroleum Institute (API)
14. Hydraulic Institute (HI)

C. The following standards have been referred to in this Section of the specifications:

ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800
ANSI B16.5	Pipe Flanges and Flanged Fittings, Steel, Nickel Alloy, and Other Special Alloys
ANSI B46.1	Surface Texture
ANSI S12.6	Method for the Measurement of the Real-Ear Attenuation of Hearing Protectors
ANSI/ASME B1.20.1	General Purpose Pipe Threads (Inch)
ANSI/ASME B31.1	Power Piping
ANSI/AWWA D100	Welded Steel Tanks for Water Storage
AWWA C206	Field Welding of Steel Water Pipe
ASTM A 48	Specification for Gray Iron Castings
ASTM A 108	Specification for Steel Bars, Carbon, Cold-Finished, Standard Quality

1.3 CONTRACTOR SUBMITTALS

- A. Shop Drawings: The Contractor shall furnish complete shop drawings for all equipment specified in the various Sections, together with all piping, valves, and controls for review by the Engineer in accordance with Section 01330 – Submittal Procedures.
- B. Operators and Maintenance Manual: The Contractor shall provide operations and maintenance manual for all equipment furnished for the project. The data shall be compiled into multiple three-ring binders. Refer to specification Section 01330 Submittal Procedures for specific requirements.
- C. Tools: The Contractor shall supply one complete set of special wrenches and other special tools necessary for the assembly, adjustment, and dismantling of the equipment. All tools shall be of best quality hardened steel forgings with bright, finish wrench heads shall have work faces dressed to fit nuts. All tools shall be suitable for professional work and manufactured by a recognized supplier of professional tools such as Snap On, Crescent, Stanley, or equal. The set of tools shall be neatly mounted in a labeled tool box of suitable design provided with a hinged cover.
- D. Spare Parts: The Contractor shall obtain and submit from the manufacturer a list of suggested spare parts for each piece of equipment. After approval, Contractor shall furnish such spare parts suitably packaged, identified with the equipment number, and labeled. Contractor shall also furnish the name, address, and telephone number of the nearest distributor for each piece of equipment. All spare parts are intended for use by the Owner, only after expiration of the guaranty period.
- E. Seismic and anchorage designs and calculations, prepared and stamped by a Licensed Professional Engineer in the State of California and in accordance with the Contract Documents.
- F. Torsional Analysis: The Contractor shall submit to the Engineer a torsional and lateral vibration analysis of the following equipment, in accordance with Section 01330 Submittal Procedures. The analysis has to be performed by a specialist experienced in this type of work and approved by the Engineer.
 - 1. All engine drives.
 - 2. All blowers and compressors with drives of 100 horsepower and over.
 - 3. All vertical pumps with universal joints and extended shafts.
 - 4. All other equipment where specified.
 - 5. The torsional natural frequency of the drive train must be avoided by + 25 percent by any exciting frequency of the equipment, throughout the entire operating range.
- G. Vibration Analysis: In his bid price the Contractor shall include at least two site visits of the abovementioned specialist, during construction and testing of the equipment, to analyze and measure the amount of equipment vibration and make his written recommendation for keeping the vibration at a safe limit.

H. Electrical and Control Submittals:

1. Electrical and control submittals shall meet the applicable requirements of Section, Electrical, and Section, Instrumentation and Controls.
2. All submittals shall include the device tag number and/or equipment number as shown on the Contract Documents.
3. Include complete information on electric power requirements. Include information on required branch circuits and electric feeders, voltages, loads, and specific locations of terminations. If disconnecting devices are required, provide information on these requirements.
4. Provide complete information on signal inputs and outputs: discrete (contact closures), and analog (4-20 milliamp signals).
5. Provide a functional description of internal and external instrumentation and controls to be supplied including list of parameters monitored, controlled, or alarmed. Include information on programmed and/or configured controls.
6. Provide a bill of materials, which is a listing that includes all of the control stations, panels, racks, instruments, components, and devices provided under this Section. Components on and within panels shall be included on the bill of materials for the panel. All components shall be grouped by component type, with the identification code and/or tag number used on the Contract Drawings where so shown. For devices not identified on the Contract Drawings with unique tag numbers, the supplier shall assign tag numbers consistent with (and not conflicting with) the tag numbers in use on the project. The list shall contain the following, as a minimum:
 - a. Instrument, panel, rack or device, tag number
 - b. Description
 - c. Quantity supplied
 - d. Reference to component datasheet and/or catalog cut
 - e. Component type
7. Provide complete submittal information on control stations, control panels, field panels, instrument racks, and other control enclosures.
8. Provide panel construction drawings, including shop drawings and catalog material. Drawings shall include dimensions and shall show the location of all panel-mounted devices as well as doors, hinges, fasteners, louvers, and subpanels. Drawings shall include a panel legend and a bill of materials. The panel legend shall list and identify front-of-panel devices by their assigned tag numbers and nameplate inscriptions. The bill of materials shall list all devices mounted within the panel that are not listed in the panel legend, and shall include the tag number, description, manufacturer, and model number for each.
9. Electrical Drawing Requirements:
 - a. Electrical drawings and data shall be complete, shall represent the equipment proposed for this project, and shall meet the applicable

requirements of Section 16000 - Requirements for Electrical Work , and Section 13400 - Instrumentation and Control System. Drawings and data shall be adequate to demonstrate that the equipment meets the requirements of the Contract Drawings and Specifications, and also to be used by the Owner for operation, maintenance, and troubleshooting of the facility.

- b. Provide electrical schematic diagrams and wiring diagrams as described in Section 16000 - Requirements for Electrical Work. They shall show locations and wiring for items specified in this Section, and also show interface wiring between items specified in this Section and other items on this project. Electrical schematic diagrams shall show circuits and device elements in ladder-diagram form without regard to physical location. Wiring diagrams shall show the connections and physical relationship of electrical devices and apparatus in circuits or groups of circuits within each control panel or other identifiable unit of equipment.
- c. For electrical schematic and wiring diagrams, manufacturer's standard drawings may be used, provided that they show the information required and are annotated to reflect the configuration for this project. For example, equipment numbers and descriptions unique to this project should be used, options not included should be stricken, signal interfaces with systems outside this package should be marked up to depict the actual interfaces on this project, information and detail should be added to meet the requirements above, and other standard and optional provisions should be annotated to match this project.
- d. Electrical drawings and data shall be identified with the device tag number and/or equipment number as shown on the Contract Documents, or otherwise shown.

10. Field Wiring Interconnection Diagram:

- a. As described in Section 16000 - Requirements for Electrical Work, participate in the development of field wiring interconnection diagram(s). Provide detailed information showing termination provisions.

11. Interface and Interconnection Coordination

- a. The supplier of the system described in this Section shall coordinate with other members of the Contractor's organization during bid and during construction on interfaces and interconnection requirements. The requirements below are not comprehensive, but instead represent minimum requirements:
- b. Coordination of power feed(s): If disconnects and/or overcurrent protection are shown and/or otherwise required, and they are not provided by the supplier of the equipment specified herein, coordinate the source of supply. Required disconnects shall be provided under this Contract. If branch circuits and/or feeders required differ from what is shown on the Contract Documents, provide power feeds as required to supply the package.
- c. Coordination of interconnection within package components: If any devices within the package are not factory wired, and/or are to be field wired, coordinate source of supply and provide complete documentation showing

the interconnection. Required interconnection shall be provided under this Contract.

- d. Coordination of interfaces and interconnections outside of the package: Provide complete coordination and information necessary to document and execute signal interfaces between the package and the remainder of the facility. Coordinate signal levels, ranges, and contact senses. For analog signals, coordinate power source.
- e. Motor Control: If any motor control is required outside of the package, Contract shall coordinate requirements and interfaces. Required motor control, complete, shall be provided under this Contract.

1.4 QUALITY ASSURANCE

- A. Inspection, Startup, and Field Adjustment: The Contractor shall demonstrate that all equipment meets the specified performance requirements. Contractor shall provide the services of an experienced, competent, and authorized service representative of the manufacturer of each item of major equipment who shall visit the site of Work to perform the following tasks:
 - 1. Assist the Contractor in the installation of the equipment.
 - 2. To inspect, check, adjust if necessary and approve the equipment installation.
 - 3. To start-up and field-test the equipment for proper operation, efficiency, and capacity.
 - 4. To perform necessary field adjustments during the test period until the equipment installation and operation are satisfactory to the Engineer.
 - 5. To instruct the Owner's personnel in the operation and maintenance of the equipment. Instruction shall include step-by-step trouble shooting procedures with all necessary test equipment.
- B. Costs: The costs of all inspection, startup, testing, adjustment, and instruction work performed by said factory-trained representatives shall be borne by the Contractor. The Owner will pay for costs of power and water. When available, the Owner's operating personnel will provide assistance in the field testing.
- C. Public Inspection: It shall be the responsibility of the Contractor to inform the local authorities, such as building and plumbing inspectors, fire marshall, OSHA inspectors, and others, to witness all required tests for piping, plumbing, fire protection systems, pressure vessels, safety systems, etc., to obtain all required permits and certificates, and pay all fees.
- D. Tolerances: Tolerances and clearances shall be as shown on the shop drawings and shall be closely adhered to. Machine work shall in all cases be of high-grade workmanship and finish, with due consideration to the special nature or function of the parts. Members without milled ends and which are to be framed to other steel parts of the structure may have a variation in the detailed length of not greater than 1/16-inch for members 30 feet or less in length, and not greater than 1/8-inch for members over 30 feet in length.

E. Machine Finish: The type of finish shall be the most suitable for the application and shall be shown in micro-inches in accordance with ANSI B46.1. The following finishes shall be used:

1. Surface roughness not greater than 63 micro-inches shall be required for all surfaces in sliding contact.
2. Surface roughness not greater than 250 micro-inches shall be required for surfaces in contact where a tight joint is not required.
3. Rough finish not greater than 500 micro-inches shall be required for other machined surfaces.
4. Contact surfaces of shafts and stems which pass through stuffing boxes and contact surfaces of bearings shall be finished to not greater than 32 micro-inches.

1.5 MANUFACTURER'S EXPERIENCE:

- A. Unless otherwise directed by the ENGINEER, all equipment furnished shall have a record of at least 5 years of successful, trouble free operation in similar applications, from the same manufacturer.
- B. The manufacturer shall also have sufficient installation experience and financial stability to ensure long-term capability to furnish, install, and service the equipment.

1.6 MANUFACTURER'S SERVICE REPRESENTATIVE

- A. Inspection, Startup, and Field Adjustment: Where required by the equipment Sections, an authorized service representative of the manufacturer shall visit the site for the number of days indicated in those Sections to witness the following and to certify in writing that the equipment and controls have been properly installed, aligned, lubricated, adjusted, and readied for operation.
 1. Installation of the equipment.
 2. Inspection, checking, and adjusting the equipment.
 3. Startup and field testing for proper operation.
 4. Performing field adjustments to ensure that the equipment installation and operation comply with requirements.
- B. Instruction of the Owner's Personnel:
 1. Where required by the individual equipment Sections, an authorized training representative of the manufacturer shall visit the site for the number of days indicated in those Sections to instruct the Owner's personnel in the operation and maintenance of the equipment, including step-by-step troubleshooting with necessary test equipment. Instruction shall be specific to the models of equipment provided.

2. The representative shall have at least two years' experience in training. A resume for the representative shall be submitted.
3. Training shall be scheduled a minimum of three weeks in advance of the first session.
4. Proposed training material and a detailed outline of each lesson shall be submitted for review. Comments shall be incorporated into the material.
5. The training materials shall remain with the trainees.
6. The Owner may videotape the training for later use with the Owner's personnel.

PART 2 PRODUCTS

2.1 GENERAL

- A. High Noise Level Location: The Contractor shall provide one personal hearing protection station, as specified herein, at each high noise level location. Said locations are defined as follows:
 1. Outdoor Location: Any single equipment item or any group of equipment items that produce noise exceeding OSHA noise level requirements for a 2-hour exposure. Where such equipment is separated by a distance of more than 20 feet, measured between edges of footings, each group of equipment shall be provided with a separate hearing protection station. For any equipment provided that exceeds a noise level of 85 dBA @ 3 feet, the Contractor shall provide and install a weatherproof sound dampening enclosure. The enclosure shall be capable for reducing noise levels for the operating equipment to less than 85 dBA @ 3 feet and shall include adequate access and ventilation openings and/or doors for operation and maintenance. Sound enclosures shall be provided at no additional cost to the District and shall be submitted to for review and approval in accordance with Section 01300 - Submittals.
 2. Indoor Location:
 - a. Any single equipment item, or any group of equipment items, located within a single room not normally occupied, produces noise exceeding OSHA noise level requirements for a 2-hour exposure.
 - b. Any single equipment item, or any group of equipment items, located within a single room normally occupied by workers, that produces noise exceeding OSHA noise level requirements for an 8-hour exposure.
- B. Personal Hearing Protection: The Contractor shall supply, in their original unopened packaging, three pairs of high attenuation hearing protectors. The ear protectors shall be capable of meeting the requirements of ANSI S12.6 and shall produce a noise level reduction of 25 dBA at a frequency of 500 Hz. The hearing protectors shall have fluid filled ear cushions and an adjustable, padded headband. The protectors shall be stored in a weatherproof, labeled, steel cabinet, furnished by the Contractor and mounted in an approved location near the noise producing equipment.

- C. Service Factors: Service factors shall be applied in the selection or design of mechanical power transmission components. Unless otherwise specified, the following load classifications shall apply in determining service factors:

Type of Equipment	Load Classification
Reciprocating Air Compressor:	
Multi-Cylinder	Moderate Shock
Single-Cylinder	Heavy Shock
Pump:	
Centrifugal or Rotary	Uniform
Reciprocating	Moderate Shock
Crane or Hoist	Moderate Shock

- D. For service factors of electric motors, see Section 16222 - Motors. Where load classifications are not specified, best modern practice shall be used.
- E. Welding: Unless otherwise specified or shown, all welding shall conform to the following:
1. Latest revision of ANSI/AWWA D100.
 2. Latest revision of AWWA C206.
 3. All composite fabricated steel assemblies which are to be erected or installed inside a hydraulic structure, including any fixed or movable structural components of mechanical equipment, shall have continuous seal welds to prevent entrance of air or moisture.
 4. All welding shall be by the metal-arc method or gas-shielded arc method as described in the American Welding Society's "Welding Handbook" as supplemented by other pertinent standards of the AWS. Qualification of welders shall be in accordance with the AWS Standards governing same.
 5. In assembly and during welding, the component parts shall be adequately clamped, supported, and restrained to minimize distortion and for control of dimensions. Weld reinforcement shall be as specified by the AWS code. Upon completion of welding, all weld splatter, flux, slag, and burrs left by attachments shall be removed. Welds shall be repaired to produce a workmanlike appearance, with uniform weld contours and dimensions. All sharp corners of material which is to be painted or coated shall be ground to a minimum of 1/32-inch on the flat.
- F. Protective Coating: All equipment shall be painted or coated in accordance with Section 09960 – Protective Coatings, unless otherwise indicated. Non-ferrous metal and corrosion-resisting steel surfaces shall be coated with grease or lubricating oil. Coated surfaces shall be protected from abrasion or other damage during handling, testing, storing, assembly, and shipping.
- G. Vibration Level: All equipment subject to vibration shall be provided with restrained spring-type vibration isolators or pads per manufacturer's written recommendations.

- H. Shop Fabrication: Shop fabrication shall be performed in accordance with the Contract Documents and the Engineer-approved shop drawings.

2.2 EQUIPMENT SUPPORTS AND FOUNDATIONS

- A. Equipment Supports: All equipment supports, anchors, and restrainers shall be adequately designed for static, dynamic, wind and seismic loads as specified on Drawing S-1. The design horizontal seismic force shall be the greater of that noted in the general structural notes or as required by the governing building code, or 10 percent of gravity. Submitted design calculations for equipment supports must bear the signature and seal of an engineer registered in the State wherein the project is to be built, unless otherwise directed.
- B. Equipment Foundations: Equipment foundations shall be as per manufacturer's written recommendations. All mechanical equipment, tanks, control cabinets, etc., shall be mounted on minimum 3.5-inch high concrete bases, as shown on standard structural details, unless otherwise shown or specified.
- C. Shop Drawings: Shop drawings shall be submitted to the Engineer for review in accordance with the requirements of Section 01330 – Submittal Procedures. Shop drawings will be considered incomplete unless clear, concise calculations are presented showing equipment anchorage forces and the capacities of the anchorage elements provided by the Contractor.

2.3 PIPE HANGERS, SUPPORTS AND GUIDES

- A. All pipe connections to equipment shall be supported, anchored, and guided to avoid stresses and loads on equipment flanges and equipment. Supports and hangers shall be in accordance with the requirements of Section 15006 - Pipe Supports.

2.4 FLANGES AND PIPE THREADS

- A. All flanges on equipment and appurtenances provided under this Section shall conform to ANSI B16.1, Class 125; or B16.5, Class 150, unless otherwise shown. All pipe threads shall be in accordance with ANSI/ASME B1.20.1, and with requirements of Section 15000 – Piping, General.

2.5 COUPLINGS

- A. Flexible couplings shall be provided between the driver and the driven equipment to accommodate slight angular misalignment, parallel misalignment, end float, and to cushion shock loads. Where required for vertical shafts, 3-piece spacer couplings or universal type couplings for extended shafts shall be installed.
- B. The Contractor shall have the equipment manufacturer select or recommend the size and type of coupling required to suit each specific application.
- C. Taper-lock bushings may be used to provide for easy installation and removal on shafts of various diameters.

- D. Where universal type couplings are shown, they shall be of the needle bearing type construction, equipped with commercial type grease fittings.

2.6 SHAFTING

- A. General: All shafting shall be continuous between bearings and shall be sized to transmit the power required. Keyways shall be accurately cut in line. Shafting shall not be turned down at the ends to accommodate bearings or sprockets whose bore is less than the diameter of the shaft. All shafts shall rotate in the end bearings and shall be turned and polished, straight, and true.
- B. Materials: Shafting materials shall be appropriate for the type of service and torque transmitted. Environmental elements such as corrosive gases, moisture, and fluids shall be taken into consideration. Materials shall be as shown or specified unless furnished as part of an equipment assembly.
1. Low carbon cold-rolled steel shafting shall conform to ASTM A108, Grade 1018.
 2. Medium carbon cold-rolled shafting shall conform to ASTM A108, Grade 1045.
 3. Corrosion-resistant shafting shall be stainless steel or Monel, whichever is most suitable for the intended service.
- C. Differential Settlement: Where differential settlement between the driver and the driven equipment may be expected, a shaft of sufficient length with 2 sets of universal type couplings shall be provided.

2.7 BEARINGS

- A. General: Bearings shall conform to the standards of the Anti-Friction Bearing Manufacturers Association, Inc. (AFBMA).
- B. To assure satisfactory bearing application, fitting practice, mounting, lubrication, sealing, static rating, housing strength, and other important factors shall be considered in bearing selection.
- C. All re-lubricatable type bearings shall be equipped with a hydraulic grease fitting in an accessible location and shall have sufficient grease capacity in the bearing chamber.
- D. All lubricated-for-life bearings shall be factory-lubricated with the manufacturer's recommended grease to insure maximum bearing life and best performance.
- E. Bearing Life: Except where otherwise specified or shown, all bearings shall have a minimum L-10 life expectancy of 5 years or 20,000 hours, whichever occurs first. Where so specified, bearings shall have a minimum rated L-10 life expectancy corresponding to the type of service, as follows:

Type of Service	Design Life (years)	L-10 Design Life (hours) (whichever comes first)
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8-hour shift	10	20,000
16-hour shift	10	40,000
Continuous	10	60,000

- F. Bearing housings shall be of cast iron or steel and bearing mounting arrangement shall be as specified or shown, or as recommended in the published standards of the manufacturer. Split-type housings may be used to facilitate installation, inspection, and disassembly.
- G. Sleeve-type bearings shall have a Babbitt or bronze liner.

2.8 GEARS AND GEAR DRIVES

- A. Unless otherwise specified, gears shall be of the helical or spiral-bevel type, designed and manufactured in accordance with AGMA Standards, with a minimum service factor of 1.7, a minimum L-10 bearing life of 60,000 hours and a minimum efficiency of 94 percent. Worm gears shall not be used, unless specifically approved by the Engineer.
- B. All gear speed reducers or increasers shall be of the enclosed type, oil- or grease-lubricated and fully sealed, with a breather to allow air to escape but keep dust and dirt out. The casing shall be of cast iron or heavy-duty steel construction with lifting lugs and an inspection cover for each gear train. An oil level sight glass and an oil flow indicator shall be provided, arranged for easy reading.
- C. Gears and gear drives as part of an equipment assembly shall be shipped fully assembled for field installation.
- D. Material selections shall be left to the discretion of the manufacturer, provided the above AGMA values are met. Input and output shafts shall be adequately designed for the service and load requirements. Gears shall be computer-matched for minimum tolerance variation. The output shaft shall have 2 positive seals to prevent oil leakage.
- E. Oil level and drain location relative to the mounting arrangement shall be easily accessible. Oil coolers or heat exchangers with all required appurtenances shall be furnished when necessary.
- F. Where gear drive input or output shafts have to connect to couplings or sprockets supplied by others, the Contractor shall have the gear drive manufacturer supply matching key taped to the shaft for shipment.

2.9 DRIVE CHAINS

- A. Power drive chains shall be commercial type roller chains and meet ANSI Standards.
- B. A chain take-up or tightener shall be provided in every chain drive arrangement to provide easy adjustment.

- C. A minimum of one connecting or coupler link shall be provided with each length of roller chain.
- D. Chain and attachments shall be of the manufacturer's best standard material and suitable for the process fluid.

2.10 SPROCKETS

- A. General: Sprockets shall be used in conjunction with all chain drives and chain-type material handling equipment.
- B. Materials: Unless otherwise specified, materials shall be as follows:
 - 1. Sprockets with 25 teeth or less, normally used as a driver, shall be made of medium carbon steel in the 0.40 to 0.45 percent carbon range.
 - 2. Type A and B sprockets with 26 teeth or more, normally used as driven sprockets, shall be made of minimum 0.20 percent carbon steel.
 - 3. Large diameter sprockets with Type C hub shall be made of cast iron conforming to ASTM A48, Class 30.
- C. All sprockets shall be accurately machined to ANSI Standards. Sprockets shall have deep hardness penetration in tooth sections.
- D. Finish bored sprockets shall be furnished complete with keyseat and set screws.
- E. To facilitate installation and disassembly, sprockets shall be of the split type or shall be furnished with taper-lock bushings as required.
- F. Idler sprockets shall be furnished with brass or Babbitt bushings, complete with oil hole and axial or circumferential grooving. Steel collars with set screws may be provided in both sides of the hub.

2.11 V-BELT DRIVES

- A. V-belts and sheaves shall be of the best commercial grade and shall conform to ANSI, MPTA, and RMA Standards.
- B. Unless otherwise specified, sheaves shall be machined from the finest quality gray cast iron.
- C. All sheaves shall be statically balanced. In some applications where vibration is a problem, sheaves shall be dynamically balanced. Sheaves operating at belt speeds exceeding 6,500 fpm may be required to be of special materials and construction.
- D. To facilitate installation and disassembly, sheaves shall be furnished complete with taper-lock or QD bushings as required.
- E. Finish bored sheaves shall be furnished complete with keyseat and set screws.

- F. Sliding motor bases shall be provided to adjust the tension of V-belts.

2.12 DRIVE GUARDS

- A. All power transmission, prime movers, machines, shaft extensions, and moving machine parts shall be guarded to conform with the Division of Industrial Safety General Industrial Safety Orders latest edition and OSHA Safety and Health Standards (29CFR1910). The guards shall be constructed of minimum 10 gage expanded, flattened steel with smooth edges and corners, galvanized after fabrication and securely fastened. Where required for lubrication or maintenance, guards shall have hinged and latched access doors.

2.13 FLEXIBLE CONNECTORS

- A. Flexible connectors shall be installed in all piping connections to engines, blowers, compressors, and other vibrating equipment and in piping systems in accordance with the requirements of the Section 15000 - Piping, General.

2.14 INSULATING CONNECTIONS

- A. Insulating bushings, unions, couplings, or flanges, as appropriate, shall be used in accordance with the requirements of the Section 15000 - Piping, General.

2.15 GASKETS AND PACKINGS:

- A. Gaskets for sleeve-type couplings shall be rubber-compound material that will not deteriorate from age or exposure to air under normal storage or use conditions. Gaskets for wastewater and sewerage applications shall be Buna "N," grade 60, or equivalent suitable elastomer. The rubber in the gasket shall meet the following specifications:
 - 1. Color - Jet Black.
 - 2. Surface - Non-blooming.
 - 3. Durometer Hardness - 74 ± 5
 - 4. Tensile Strength – 1000 psi Minimum
 - 5. Elongation – 175 percent Minimum
- B. The gaskets shall be immune to attack by impurities normally found in water or wastewater. All gaskets shall meet the requirements of ASTM D2000, AA709Z, meeting Suffix. B13 Grade 3, except as noted above. All gaskets shall be compatible with the piping service and fluid utilized.
- C. Packing around valve stems and reciprocating shafts shall be of compressible material, compatible with the fluid being used. Chevron-type "V" packing shall be Gatlock No. 432, John Crane "Everseal," or equal.

- D. Packing around rotating shafts (other than valve stems) shall be "O"-rings, stuffing boxes, or mechanical seals, as recommended by the manufacturer and approved by the Engineer, in accordance with Section 11100 – Pumps, General.

2.16 NAMEPLATES

- A. Equipment nameplates of stainless steel shall be engraved or stamped and fastened to the equipment in an accessible location with No. 4 or larger oval head stainless steel screws or drive pins. Nameplates shall contain the manufacturer's name, model, serial number, size, characteristics, and appropriate data describing the machine performance ratings.

2.17 SAFETY REQUIREMENTS

- A. Where work areas are located within a flammable or toxic gas environment, suitable gas detection, ventilating, and oxygen deficiency equipment shall be provided. Workers shall be equipped with approved breathing apparatus.

2.18 OVERLOAD PROTECTION

- A. General: Unless otherwise specified in individual equipment Sections, all equipment drives incorporating overload protection shall be provided with an overload protection device as follows:

1. Mechanical System: The overload protection shall be a mechanical device to provide for reliable protection in the event of excessive overload. It shall be a ball detent type designed for long-term repeatability and life. It shall be infinitely adjustable by a single adjusting nut. Once set it shall be tamperproof and incorporate a torque monitoring and control system. It shall activate an alarm set for 85 percent, and a motor cutout switch set for 100 percent of maximum continuous running torque. A visual torque indication shall be provided and oriented so that it may be read from the walkway. The dial shall be calibrated from 0 to 100 percent of maximum continuous running torque. The design of the torque limiter should initiate the mechanical disengagement of the drive upon overload. Each unit shall be suitable for outdoor/corrosive environments with a protective finish, corrosion inhibiting lubricants and a stainless steel cover.

2. Electronic System

- a. As an alternative to the mechanical system, the overload protection may be an Electronic Torque Monitoring Control System capable of displaying torque, rpms, one level of overload, and two levels of overload of the drive system. It shall incorporate a time-delay for startup and a voltage monitoring and compensation circuit for up to +15 percent variation.
- b. The overload device shall have an enclosure suitable for outdoor installation at temperatures of 0-70 degrees C, and relative humidity up to 95 percent. A visual torque dial shall be provided and oriented so that it can be easily read from the walkway.
- c. The torque monitoring system shall be calibrated to alarm and shut down the system in the event the torque drops to 50 percent of normal running; alarm at 85 percent of maximum continuous running torque and shut down

the motor at maximum continuous running torque of the equipment. The system shall be calibrated at the factory of the equipment manufacturer and it shall be capable of monitoring twice the maximum continuous running torque of the equipment.

B. Manufacturers, or Equal:

1. American Autogard Corporation.
2. Ferguson Machine Company.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. A complete set of manufacturer's instructions covering storage, installation, operation, lubrication, and maintenance shall be furnished to the Owner no later than the date the equipment is shipped. Care during storage and procedures for installation, lubrication, and startup of the equipment and motors shall be in strict conformance with the manufacturer's instructions.
- B. The Contractor shall prepare and load all material and articles for shipment in a manner that protects the equipment and coatings from damage in transit, shall include a packing list, and shall be responsible for and make good any and all damage. During shipping the rotating elements shall be suitably supported or disassembled to protect bearings.
- C. Equipment furnished shall be shipped to the site in enclosed, weather-tight, sealed containers in a manner designed to protect the pumping units against damaging stress caused by sudden acceleration or deceleration. For equipment 25 horsepower or greater, two recording accelerometers, designed to record the magnitude of any sudden impact in all three directions (X, Y, Z) on continuous strip charts, shall be shipped with, and fixed to each assembly or its packing container. Upon arrival of each shipment, the accelerometers shall be removed in the presence of representatives of the Engineer, the Contractor, and the equipment manufacturer. If magnitude of the maximum acceleration exceeds 3.0 times the acceleration due to the force of gravity (3.0 g), the assembly or subassembly shall be dismantled and completely inspected. All damage shall be corrected to the complete satisfaction of the Engineer before the assembly is incorporated in to the work. The Contractor shall bear all costs arising out of dismantling, inspection, repair, and reassembly.
- D. Where necessary, heavy parts or machines shall be mounted on skids or shall be crated, and any articles or materials that might otherwise be lost shall be boxed or wired in bundles and plainly marked for identification. The gross weight shall be clearly marked on all boxes or skidded equipment packages exceeding 200 pounds. All parts exceeding 200 pounds gross weight shall be prepared for shipment so that slings for handling by a crane may be readily attached while the parts are on the car or transport truck. Boxed parts, where it is unsafe to attach slings to the box, shall be packed with slings attached to the part, the slings to

project through the box or crate so that attachment to the hoisting equipment can be readily made.

- E. All accessories and spare parts shall be packed separately in containers plainly marked "ACCESSORIES ONLY" or "SPARE PARTS ONLY." All packing materials shall be fire retardant. A packing list, listing the contents of each container, shall be placed in a moisture proof envelope, and securely fastened to the outside of the container.
- F. All parts shall be properly lubricated and protected so that no damage or deterioration will occur even during a prolonged delay from the time of shipment until installation is completed and the pumps are ready for operation.
- G. Finished ferrous surfaces not painted shall be properly protected to prevent rust and corrosion.
- H. The finished surfaces of all exposed flanges shall be protected by strong wooden blind flanges.
- I. Each equipment shall be properly crated to protect the units against damage during shipment.

3.2 INSTALLATION

- A. Install in accordance with the manufacturer's printed instructions.
- B. Alignment: All equipment shall be field tested to verify proper alignment, operation as specified, and freedom from binding, scraping, vibration, shaft runout, or other defects. Equipment drive shafts shall be measured just prior to assembly to ensure correct alignment without forcing. Equipment shall be secure in position and neat in appearance.
- C. Lubricants: The Contractor shall provide the necessary oil and grease for initial operation.
- D. The Contractor shall accomplish installation with assistance from the Manufacturer.

3.3 TESTING

- A. General: Provide testing in accordance with Section 01756 - Facility Startup.
- B. Factory Testing
 - 1. The Contractor shall be responsible for all costs associated with inspection and testing of materials, products, or equipment at the place of manufacture, unless specified otherwise.
 - 2. The following tests shall be conducted on each indicated system:
 - a. Equipment Systems: All equipment systems 10 hp and larger shall be tested at the factory in accordance with the applicable American National Standard. Tests shall be performed using the complete system to be

furnished, including the motor. For motors smaller than 100 hp, the manufacturer's certified test motor shall be acceptable. Testing of prototype models will not be acceptable.

- b. Factory Witnessed Tests: All equipment, variable speed drives, and motors, 125 hp and larger shall be factory-tested as complete assembled systems and may be witnessed by the OWNER and ENGINEER. The CONTRACTOR shall give the ENGINEER a minimum of 2 weeks notification prior to the test. At least 2 weeks prior to the test, CONTRACTOR shall submit for review and approval a copy of the proposed test procedure. All costs for OWNER and ENGINEER shall be borne by the OWNER. Test results shall be submitted to the ENGINEER and no equipment shall be shipped until the test data have been approved by the ENGINEER.
- c. Acceptance: In the event of failure of any equipment to meet any of the requirements, the CONTRACTOR shall make all necessary modifications, repairs, or replacements to conform to the requirements of the Contract Documents and the pump shall be re-tested at no additional cost to the OWNER until found satisfactory.

C. Functional Testing

- 1. The CONTRACTOR shall bear all costs of the functional tests, including related services of the manufacturer's representative, except for power and water which the OWNER will bear. If available, the OWNER'S operating personnel will provide assistance in functional testing. All equipment and instrumentation required for the testing shall be provided by the CONTRACTOR.
- 2. The final adjustments and inspections shall be made by factory-trained and authorized service personnel other than sales representatives, who also shall supervise the installation and test operation. CONTRACTOR shall include in bid, allowance for factory-trained service personnel to adjust all of the said equipment to be installed by CONTRACTOR until this equipment has been tested by the CONTRACTOR and the results of these tests are satisfactory to the ENGINEER or his designated representative.
- 3. Functional testing will be witnessed by the ENGINEER. The CONTRACTOR shall give notice to the OWNER/ ENGINEER two weeks prior to the scheduled functional field test date.
- 4. At least 2 weeks prior to the test, Contractor shall submit for review and approval a copy of the proposed functional test procedure.
- 5. The following functional testing shall be conducted:
 - a. Electrical and instrumentation tests shall conform to the requirements of the Sections under which that equipment is specified.
 - b. The equipment shall operate as described under the control strategy outlined in the instrumentation specification.
 - c. A field functional acceptance test shall be made of the entire system, including instruments, controls, alarms, plant control system, control strategy, motors, VFDs, and valves, to ensure compliance with the performance specified herein.
- 6. In the event any system fails to meet the test requirements, it shall be modified and retested as above until it satisfies the requirements.

7. After each equipment system has satisfied the requirements, the Contractor shall certify in writing that it has been satisfactorily tested and that all final adjustments have been made. Certification shall include the date of the tests, a listing of all persons present during the tests, and the test data.

D. Performance Testing

1. Where required by the individual equipment sections, each system shall be performance tested, after installation to demonstrate satisfactory operation without excessive noise, vibration, or overheating of bearings. The performance of each equipment, motor, and VFD shall be verified.
2. All expenses for conducting the performance testing shall be paid by the **CONTRACTOR**. All equipment and instrumentation required for the testing shall be provided by the Contractor.
3. The final adjustments and inspections shall be made by factory-trained and authorized service personnel other than sales representatives, who also shall supervise the installation and test operation. Contractor shall include in bid, allowance for factory-trained service personnel to adjust all of the said equipment to be installed by Contractor until this equipment has been tested by the Contractor and the results of these tests are satisfactory to the Engineer or his designated representative.
4. Performance testing will be witnessed by the Engineer. The Contractor shall give notice to the Owner/Engineer 2 weeks prior to the scheduled test date.
5. At least 2 weeks prior to performance test, Contractor shall submit for review and approval a copy of the proposed performance test procedure.
6. The following performance testing shall be conducted:
 - a. Startup, check, and operate the system over its entire speed range. Vibration shall be within the amplitude limits recommended by the specified Standards over the range of operating conditions defined by the Engineer.
 - b. Obtain concurrent readings of motor voltage, amperage, for at least four operating conditions. Check each power lead to the motor for proper current balance.
 - c. Determine bearing temperatures by contact type thermometer. A run time of at least 20 minutes shall precede this test unless insufficient liquid volume is available.
7. The tests shall demonstrate that the equipment has been properly installed, aligned and connected, is free of mechanical defects, electrical defects, excessive vibration, overheating or overloading, and that the control system performs as specified and meets all operating criteria. All parts shall operate satisfactorily in all respects and in accordance with the specified requirements for the full duration of the test period. If any part of a unit shows evidence of unsatisfactory or improper operation during the test period, correction or repairs shall be made by the Contractor and the full performance test shall be redone for that unit after all parts operate satisfactorily.
8. After each pumping system has satisfied the requirements, the Contractor shall certify in writing that it has been satisfactorily tested and that all final

adjustments have been made. Certification shall include the date of the tests, a listing of all persons present during the tests, and the test data.

3.4 COUPLINGS

- A. The Contractor shall have the equipment manufacturer select or recommend the size and type of coupling required to suit each specific application; installation shall be per equipment manufacturer's printed recommendations.

3.5 INSULATING CONNECTIONS

- A. All insulating connections shall be installed in accordance with the manufacturer's printed instructions.

3.6 PIPE HANGERS, SUPPORTS, AND GUIDES

- A. Hangers, supports, and guides shall be spaced in accordance with ANSI/ASME B.31.1 standard, and with tables in Section 15006 - Pipe Supports.

3.7 PACKAGED EQUIPMENT

- A. When any system is furnished as pre-packaged equipment, the Contractor shall coordinate all necessary space and structural requirements, clearances, utility connections, signals, and outputs with his subcontractors, to avoid later change orders.
- B. If the packaged system has any additional features (as safety interlocks, etc.), other than specified, the Contractor shall coordinate such features with the Engineer and furnish all material and labor necessary for a complete installation as required by the manufacturer, at no additional cost to the Owner.

END OF SECTION

SECTION 11052 – AUTOMATIC REFRIDGERATED SAMPLERS

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall furnish and install one (1) automatic sampling unit including automatic wastewater sampler, refrigerated sample collector, and sampling chamber and all necessary piping, pumps, connections, controls, mounts, valves, motors, and appurtenances for a complete and operable installation, in accordance with the requirements of the Contract Documents, in particular Section 11000, Equipment General Provisions.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Except as otherwise indicated, the current editions of the Specifications and Standards listed in Section 11000 Equipment General apply to the work of this Section.

NEMA 250-1997

Enclosures for Electrical Equipment

1.3 CONTRACTOR SUBMITTALS

- A. General: CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished this Section and in referenced Sections.
- B. Shop Drawings and Samples: In addition to the requirements of Section 01330 Submittal Procedures, CONTRACTOR shall submit the following:
 - 1. Make, model, weight, and horsepower of each unit
 - 2. MANUFACTURER's catalog information, descriptive literature, specifications, and identifications of materials of construction.
 - 3. Detailed Drawings: Structural, mechanical, and electrical, showing equipment fabrications and interface with other items including dimension, size, and locations of connections to other work, and weights of associated equipment.
 - 4. External utility requirements such as water, power, drains, etc.
 - 5. Functional description of internal and external instrumentation and controls to be supplied including list of parameters monitored, controlled, or alarmed.
 - 6. Control panel elevation drawings showing construction and placement of operator interface devices and other elements.
 - 7. Power and control wiring diagrams, including terminals and numbers.
- C. O & M Manuals: The CONTRACTOR shall provide operators and maintenance data for all equipment furnished for the project in accordance with Section 01730, Operation and Maintenance Data.
- D. Tools: Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the WORK hereunder; such tools shall be suitably stored in metal

tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

- E. Certifications: The CONTRACTOR shall obtain written certification from the MANUFACTURER, addressed to the OWNER, stating that the equipment will efficiently and thoroughly performed the required functions in accordance with these Specifications when the specified equipment is intend for outdoor use in a wastewater treatment application.

1.4 QUALITY ASSURANCE

- A. CONTRACTOR shall submit the following:

1. MANUFACTURER's Certificate of Proper Installation
2. Functional Test Certification
3. Factory performance test reports
4. Special shipping, storage and protection, and handling instructions
5. MANUFACTURER's printed installation instructions
6. List of suggested spare parts to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance.
7. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.

- B. Warranty

1. A written suppliers warranty shall be provided for the equipment specified in this section as required in Division 1.

1.5 MANUFACTURERS SERVICE REPRESENTATIVE

- A. Manufacturer's Representative. In accordance with the requirements of Section 01782, Operating and Maintenance Data, a Manufacturer's Representative shall be present at the site or classroom designated by the OWNER to provide the services and minimum person-days listed below, travel time excluded.

1. 0.5 person-days for installation assistance and inspection,
2. 0.5 person-days for functional and performance testing
3. 0.5 person-days for pre-startup training of OWNER's personnel.

PART 2 PRODUCTS

2.1 GENERAL – HW-EQP1

- A. Each composite sampler/pump shall be a self-contained, factory pre-wired, floor-standing unit with the sampler located above the refrigerated sample collector. The sampler shall be the peristaltic pump type. Each unit shall be mounted in a frame or

cabinet that provides a minimum of one inch of clearance between the floor and the bottom of the refrigerated sample collector. Each sampler shall have the capability to adjust sampling mode and frequencies.

- B. If not supplied as one unit, the sampler and refrigerated sample collector shall be securely attached to each other and the assembly of both rigidly attached to the foundation. Each refrigerated collector shall have the capacity to hold a 5-gallon container. The container shall have two carrying handles and fully removable lids for cleaning.

2.2 PERFORMANCE REQUIREMENTS

- A. Sampling Capacity: Each sampler shall be capable of drawing a liquid sample a vertical height of 20 feet through a minimum 3/8-inch inside diameter tube at a rate not less than 1.9 ft/sec through 15 feet of tubing.
- B. Sampling Cycle: Each sampler shall be capable of taking a sample from 10 ml to 9,999 ml per sampling cycle. The sampling cycle shall be initiated by the external flow signal, or from the internal timer, or by the manual switch. After re-purging the suction line, all electrical timers, switches, and valves shall reset to the appropriate settings to begin another sampling cycle.
- C. Refrigerated Collector
 - 1. Reach refrigerated collector shall be capable of maintaining a temperature in the collector compartment between 0 degrees C and 8 degrees C with an ambient outside temperature of 115 degrees F and shall operate on 115 Volt single phase 60-Hz power. The sampler control will automatically shut down when the collector is full.
- D. Sample Pump
 - 1. Sampled fluid shall only contact the sample probe, the sample pump tubing, and the sample container.
 - 2. The sample pump shall be peristaltic type having a capacity of at least 3000 ml/minute through 3/8-inch silicone rubber tubing.
 - 3. The peristaltic pump shall air purge the sample line before and after each sample is collected.
 - 4. Purging shall be automatically controlled without adjustment.

2.3 MATERIALS OF CONSTRUCTION

- 1. General: All materials shall be suitable for the intended application; materials not specified 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.

2. Container: The container shall be constructed of polyethylene plastic or stainless steel, cylinder shaped.
3. Fasteners: All anchor bolts, nuts, and washers shall be 316 stainless steel.
4. Pump Construction: Each pump shall be of the peristaltic type with a capacity, suction lift, and discharge head sufficient for the sampling system of the unit. The pump shall be a peristaltic pump made of reinforced engineering plastic for corrosion resistance.
5. Sample Tube: Each sampler shall be equipped with a length of Dow Corning Silastic Rx50 medical grade tubing suitable for connection with the sampling chamber. Inside diameter of the tubing shall not be less than 3/8-inch. The tubing shall be connected using stainless steel hose clamps. The supply suction tubing from sample point to sampler shall be placed in a 2-inch schedule 80 PVC carrier pipe clamped to the concrete. A strainer will be provided on the suction end of the carrier pipe.
6. Enclosure: Each sampler/controller shall be enclosed in a reinforced fiber glass cabinet with a UV-resistant gel coat and shall be rated NEMA 4 or 6 as needed to comply with hazardous classifications of the environments in which they are installed. The enclosure shall be suitable for an outdoor installation. The cabinet shall contain access doors with locking mechanism. All equipment within the cabinet shall be easily accessible for maintenance.

2.4 CONTROLS

- A. Operating Modes: Each sampler shall be capable of operating in any of the following 3 modes:
 1. Flow proportional basis from an external signal.
 2. Time proportional basis from an internal timer.
 3. Manual basis by activation of a switch on the sampler.
- B. Control: The sampler shall accept an external 4-20 mA flow signal, and shall convert the signal as required within the sampler. The sampler shall be capable of operation from the flow signal. The sampler shall not load the analog loop in excess of 250 ohms.
- C. Timer: The internal timers shall be capable of initiating the sampling sequence after a preset time has elapsed. This preset time shall be variable from 4 minutes to minimum 12 hours.
- D. Status Monitoring: Each sampler shall be provided with a dry set of electrical contacts for operational status monitoring, closing at the start of the sampling sequence, and remaining closed until the entire sampling sequence has been completed. The electrical contacts shall be rated no less than 5-amps at 24 volts dc and 120 V-60 Hz.
- E. Controls shall be supplied per Section 13400 Instrumentation and Control System and Section 13475 Control Strategies.

2.5 MOTOR

- A. Pump Motor: Each motor shall be 1800 rpm, TEFC and shall not be overloaded when the pump is operated at any point on the H/Q curve within the recommended operating range of the pump.
- B. Pump Power Supply: Each pump shall operate on 115-volt, single-phase, 60-Hz power, and it shall be supplied with a waterproof electrical junction box attached to the exterior for electrical connections for power and signals.
- C. Motors shall be in accordance with Section 16222 Motors.

2.6 SPARE PARTS

- A. Spare Parts: Each sampler shall be furnished with one year's supply of the MANUFACTURER's suggested spare parts and any other elements subject to wear or frequent replacement. All parts shall be properly labeled and identified with the name and number of the equipment to which they belong. The CONTACTOR shall furnish 100 feet of 3/8" ID Teflon tubing for sample tubing replacement.

2.7 PROTECTIVE COATING

- A. General: Protective coating of samplers shall conform to the requirements of this Section. All other equipment shall be coated in accordance with the requirements of Section 09960, Protective Coatings.
- B. Surface Preparation: All steel surfaces of samplers and refrigerated sample collectors shall be blast cleaned in the shop to a commercial blast cleaned surface conforming to SSPC-SP-6. All dust shall be removed prior to coating. Surfaces shall be coated the same day sandblasting is performed.
- C. Protective Coating: All steel surfaces of samplers, refrigerated sample collectors and supporting framework, if any, shall be shop coated with a baked epoxy powder coating to a minimum dry film thickness of 12 mils. Powder coating shall be applied by the fluidized bed or electrostatic spray method by qualified, experienced personnel. Oven curing shall conform to the recommendations of the epoxy powder MANUFACTURER. Interior surfaces of samplers and sample collectors shall be white. The exterior color shall be as directed by the ENGINEER.
- D. The CONTRACTOR is cautioned to use care during installation to avoid damage to the protective coatings on this equipment. If the coating is damaged during installation, the CONTRACTOR will be required to return the equipment to the MANUFACTURER for recoating. Field touchup will not be acceptable.

2.8 MANUFACTURERS

- A. MANUFACTURER's Experience: MANUFACTURERS shall have had previous experience in such manufacture and shall, upon request of the ENGINEER, furnish the names of not less than 5 successful installations of its equipment of comparable nature to that offered under this contract. All manufactured items provided under this Section shall be new, of current manufacture, and shall be the products of reputable manufactures specializing in the manufacture of such products. The MANUFACTURER's Qualifications covered in this Section shall be submitted to the ENGINEER.

- B. Unit Responsibility: A single MANUFACTURER shall be made responsible for furnishing the WORK and for coordination of design, assembly, testing, and installation of the WORK of each composite sampler system; however, the CONTRACTOR shall be responsible to the OWNER for compliance with the requirements of the contract documents.
- C. Manufacturers or Equal:
 - 1. Hach (Sigma).
 - 2. Teledyne (Isco).

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. A complete set of MANUFACTURER's instructions covering storage, installation, operation, lubrication, and maintenance shall be furnished to the OWNER no later than the date the equipment is shipped. Care during storage and procedures for installation, lubrication, and startup of the equipment and motors shall be in strict conformance with the MANUFACTURER's instructions.
- B. The CONTRACTOR shall prepare and load all material and articles for shipment in a manner that protects the equipment and coatings from damage in transit, shall include a packing list, and shall be responsible for and make good any and all damage.
- C. All accessories and spare parts shall be packed separately in containers plainly marked "ACCESSORIES ONLY" or "SPARE PARTS ONLY." All packing materials shall be fire retardant. A packing list, listing the contents of each container, shall be placed in a moisture proof envelope and securely fastened to the outside of the container.

3.2 INSTALLATION

- A. Install in accordance with the MANUFACTURER's printed instructions.
- B. Alignment: All equipment shall be field tested to verify proper alignment, operation as specified, and freedom from binding, scraping, vibration, shaft runout, or other defects. Pump drive shafts shall be measured just prior to assembly to ensure correct alignment without forcing. Equipment shall be secure in position and neat in appearance.
- C. Lubricants: The CONTRACTOR shall provide the necessary oil and grease for initial operation.

3.3 TESTING

- A. Field Tests
 - 1. Upon completion of the installation, each piece of equipment and each system shall be field-tested for satisfactory operation without excessive noise, vibration, overheating, etc. All equipment must be adjusted and checked for misalignment, clearances, supports, and adherence to safety standards.
 - 2. Field testing will be witnessed by the ENGINEER. The CONTRACTOR shall furnish three days advance notice of field testing.

3. The CONTRACTOR shall bear all costs of field tests, including related services of the MANUFACTURER's representative, except for power and water which the OWNER will bear. If available, the OWNER's operating personnel will provide assistance in field testing.

B. Performance Testing

1. Performance testing of the full-scale equipment shall be required in accordance with Section 01756 Facility Startup.

END OF SECTION

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SECTION 11100 – PUMPS, GENERAL

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall provide all pumps, motors, and pumping appurtenances, complete and operable, in accordance with the Contract Documents. The provisions of this Section shall apply to all pumps and pumping equipment except where otherwise indicated in the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

ASTM A48	Specification for Gray Iron Castings
ASTM B62	Specification for Composition Bronze or Ounce Metal Castings
ASTM B584	Specification for Copper Alloy Sand Castings for General Applications.
ANSI/ASME B16.1	Cast Iron Pipe Flanges and Flanged Fittings
ANSI/IEEE 112	Test Procedure for Polyphase Induction Motors and Generators
ANSI/IEEE 115	Test Procedure for Synchronous Machines
ANSI/HI 1.6	American National Standard for Centrifugal Pump Tests
ANSI/HI 2.6	American National Standard for Vertical Pump Tests

- A. The requirements of Section 11000 – Equipment, General are applicable to this section.

1.3 CONTRACTOR SUBMITTALS

- A. General: CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished this Section and in referenced Sections in accordance with the requirements of Section 01300 Submittals.
- B. Shop Drawings and Samples: In addition to the requirements of Section 01330, CONTRACTOR shall submit the following:
 - 1. Pump name, identification number, and Specification Section number.
 - 2. Performance data curves showing head, capacity, horsepower demand, NPSH required, and pump efficiency over the entire operating range of the pump. The equipment manufacturer shall indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at the design flow conditions and the maximum and minimum flow

conditions. A family of performance curves at intervals of 100 rpm from minimum speed to maximum speed shall be provided for each centrifugal pump equipped with a variable speed drive.

3. The CONTRACTOR shall require the Manufacturer to indicate the limits on the performance curves recommended for stable operation without surge, cavitation, or excessive vibration. The stable operating range shall be as wide as possible based on actual hydraulic and mechanical tests.
 4. Assembly and installation drawings including shaft size, seal, coupling, bearings, anchor bolt plan, part nomenclature, material list, outline dimensions, and shipping weights.
 5. Data, in accordance with Section 16222 –Motors, for the electric motor proposed for each pump.
 6. Elevation of proposed Local Control Panel showing panel-mounted devices, details of enclosure type, single line diagram of power distribution, and current draw of panel, and list of all terminals required to receive inputs or to transmit outputs from the Local Control Panel.
 7. Wiring diagram of field connections with identification of terminations between Local Control Panels, junction terminal boxes, and equipment items.
 8. Complete electrical schematic diagram.
 9. Torsional Analysis
- C. O & M Manuals: The CONTRACTOR shall provide operations and maintenance data for all equipment furnished for the project in accordance with Section 01730, Operation and Maintenance Data. Prior to start up the CONTRACTOR shall furnish six copies of the Operations and Maintenance Manuals for each pump Section.
- D. Tools: Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the WORK hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.
- E. Quality Assurance: CONTRACTOR shall submit the following:
1. Manufacturer's Certificate of Proper Installation
 2. Functional and Performance Test Results and Certifications
 3. Factory performance test reports:
 - a. Signed, dated, and certified factory test data for each pump system which requires factory testing, submitted before shipment of equipment.
 4. Special shipping, storage and protection, and handling instructions
 5. Manufacturer's printed installation instructions

6. List of suggested spare parts to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance. Spare Parts List shall contain the furnished spare parts for each pump Section.
7. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.
8. Certified pump performance curves for each pump section signed by officer of manufacturer. Certification to include manufactures guarantee performance of flow, head, and efficiency at specified conditions.
9. The CONTRACTOR shall obtain and submit written certification from the designated single manufacturer, addressed to the OWNER, stating that the equipment will efficiently and thoroughly perform the required functions in accordance with these Specifications and as shown, and that the designated single manufacturer accepts the CONTRACTOR'S assignment of full responsibility for coordination of all equipment, including operators and controls, and services required for proper installation and operation. The CONTRACTOR shall submit all such certificates to the ENGINEER.

1.4 QUALITY ASSURANCE

- A. Fabrication, delivery, and installation shall be in accordance with applicable Hydraulic Institute Standards and requirements.
- B. Pumps are to be engineered and manufactured under a Manufacturer's written Quality Assurance program. The Quality Assurance program is to be in effect for at least (5) years, to include a written record for periodic internal and external audits to confirm compliance with such program.
- C. Warranty
 1. A written suppliers warranty shall be provided for the equipment specified in this section as required in Division 1.

1.5 MANUFACTURER'S SERVICE REPRESENTATIVE

- A. Manufacturer's Representative. In accordance with the requirements of Section 01730, Operation and Maintenance Data, a Manufacturer's Representative shall be present at the site or classroom designated by the OWNER to provide the services and minimum person-days listed in the individual pump sections, travel time excluded.
- B. Inspection, installation assistance, functional and performance testing: Where required by the individual pump Sections, an authorized service representative of the manufacturer shall visit the site for the time indicated in those Sections to witness the following and to certify in writing that the equipment and controls have been properly installed, aligned, lubricated, adjusted, and readied for operation.
 1. Installation of the equipment.
 2. Inspection, checking, and adjusting the equipment.

3. Startup and field functional and performance testing for proper operation.
 4. Performing field adjustments to ensure that the equipment installation and operation comply with requirements.
- C. Pre-startup training of the OWNER's Personnel:
1. Where required by the individual pump Sections, an authorized training representative of the manufacturer shall visit the site for the time indicated in those Sections to instruct the OWNER's personnel in the operation and maintenance of the equipment, including step-by-step troubleshooting with necessary test equipment. Instruction shall be specific to the models of equipment provided.
 2. The representative shall have at least two years of experience in training. A resume for the representative shall be submitted.
 3. Training shall be scheduled as specified in Section 01782, Operating and Maintenance Data.
 4. Proposed training material and a detailed outline of each lesson shall be submitted for review as specified in Section 01782, Operating and Maintenance Data. Comments shall be incorporated into the material.
 5. The training materials shall remain with the trainees.
 6. The OWNER may videotape the training for later use with the OWNER's personnel.
- D. A work day is defined as an eight hour period at the site, excluding travel time.
- E. The ENGINEER may require that the inspection, startup, and field adjustment and train services to be furnished over separate trips for each pump Section as specified in each pump Section.

PART 2 PRODUCTS

2.1 GENERAL

- A. Compliance with the requirements of the individual pump Sections may necessitate modifications to the manufacturer's standard equipment.
- B. All components of each pump system provided under the pump Sections shall be entirely compatible. Each unit of pumping equipment shall incorporate all basic mechanisms, couplings, electric motors or engine drives, variable speed controls, necessary mountings, and appurtenances.
- C. Performance Curves: All centrifugal pump curves shall be continuously rising from maximum flow to the shutoff.

2.2 PUMP SCHEDULE

PUMP NO.	NAME	LOCATION	PROCESS FLUID	PUMP TYPE
PS-PMP-1	North Primary Sludge Pump	South Clarifier, North Sludge Pump Station	Primary Sludge	Double Disc Pump
PS-PMP-2	South Primary Sludge Pump	South Clarifier, South Sludge Pump Station	Primary Sludge	Double Disc Pump
DS-PMP-1	Digester Sludge Transfer Pump	South Clarifier, South Sludge Pump Station	Digester Sludge	Double Disc Pump

2.3 PUMP COMPONENTS

- A. All materials shall be suitable for the intended application; materials not specified 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:
- B. Cast iron pump casings and bowls shall be of close-grained gray cast iron, conforming to ASTM A48 - Gray Iron Castings, Class 30, or equal.
- C. Bronze pump impellers shall conform to ASTM B62 - Composition Bronze or Ounce Metal Castings, or B584 - Copper Alloy Sand Castings for General Applications, where dezincification does not exist.
- D. Stainless steel pump shafts shall be Type 416 or 316. Miscellaneous stainless steel parts shall be of Type 316, except in a septic environment.
- E. Anchor bolts, washers, and nuts in Standard Service (Non-Corrosive Application) shall be galvanized steel in accordance with the requirements of Section 05500 – Miscellaneous Metals. Anchor bolts, washers, and nuts in Corrosive Service as defined in Section 05500 shall be stainless steel in accordance with that Section.
- F. Flanges: Suction and discharge flanges shall conform to ANSI/ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800 or B16.5 - Pipe Flanges and Flanged Fittings dimensions.
- G. Lubrication: Vertical pump shafts of clean water pumps shall be product water-lubricated, unless otherwise indicated. Deep-well pumps and pumps with dry barrels shall have water- or oil-lubricated bearings and seals and enclosed lineshafts. Pumps for sewage, sludge, and other process fluids shall be lubricated as indicated.
- H. Handholes: Handholes on pump casings shall be shaped to follow the contours of the casing to avoid any obstructions in the water passage.
- I. Vortex Suppressors: Vertical pumps with marginal submergence shall be provided with vortex suppressors.
- J. Drains: All gland seals, air valves, cooling water drains, and drains from variable speed drive equipment shall be piped to the nearest floor sink, or drain, with galvanized steel pipe or copper tube, properly supported with brackets.

- K. Grease Lubrication: For all vertical propeller, mixed-flow, and turbine pumps, other than deep well pumps, of bowl sizes 10-inches and larger, the CONTRACTOR shall provide a stainless steel tube attached to the column for grease lubrication of the bottom bearing.
- L. Stuffing Boxes: Where stuffing boxes are specified for the pump seal, they shall be of the best quality, using the manufacturer's suggested materials best suited for the specific application. For sewage, sludge, drainage, and liquids containing sediments, the seals shall be flushed as shown on the drawings, using lantern rings.
1. Unless otherwise indicated, the packing material shall be interlaced Teflon braiding, containing 50 percent ultrafine graphite impregnation to satisfy the following:
 2. Shaft Speeds: Up to 2,500 fpm.
 3. Temperature: Up to 500 degrees F.
 4. pH Range: 0-14.
 5. If fresh water is not available, the seal shall be flushed with utility water from the plant's utility water system.
- M. Mechanical Seals: Mechanical seals shall be flushed as indicated in the contract drawings.
1. Mechanical seals shall be as manufactured by the following, unless indicated differently in the individual pump sections, in which case seals shall be as indicated in the individual pump sections:
 - 1) Chesterton mechanical split cartridge type, Chesterton 442.
 - 2) John Crane mechanical split cartridge type, John Crane 3710
 2. Where indicated, a buffer fluid must be circulated a minimum 20 psi above discharge pressure, or as required by the manufacturer, in order to maintain reliable seal performance.
 3. Mechanical seals for all services other than chemicals and corrosives shall be equipped with nonclogging, single coil springs and nonsliding, internal, secondary elastomers. Metal parts shall be Type 316 stainless steel, Alloy 20, or Hastelloy B or C.
 4. A seal water flush system shall be provided for flushing mechanical seals. The CONTRACTOR is responsible for coordinating and furnishing and installing a system, complete and self-contained to the pump, with connections to the mechanical seal housing, including an isolation valve and other appurtenances as indicated in the Drawings.
- N. Pump appurtenances

1. Nameplates: Each pump shall be equipped with a stainless steel nameplate indicating serial numbers, rated head and flow, impeller size, pump speed, and manufacturer's name and model number.
2. Solenoid Valves: The pump manufacturer shall provide solenoid valves on the water or oil lubrication lines and on all cooling water lines. Solenoid valve electrical ratings shall be compatible with the motor control voltage.
3. Gages:
 - a. All pumps (except sample pumps, sump pumps, and hot water circulating pumps) shall be equipped with pressure gages installed at pump discharge lines. Pump suction lines shall be provided with compound gages. Gages shall be located in a representative location, where not subject to shock or vibrations, in order to achieve true and accurate readings.
 - b. Where subject to shock or vibrations, the gages shall be wall-mounted or attached to galvanized channel floor stands and connected by means of flexible connectors.
 - c. Pressure and compound gages shall be provided in accordance with Section 13400 – Instrumentation and Control Systems.

2.4 MOTORS

- A. Unless otherwise indicated in the individual pump sections, each pump shall be provided with a Series 400 stainless steel vertical, solid shaft; premium, high thrust, TEFC enclosure, 460 volt, 3-phase, 60 Hertz heavy duty, electric motor in accordance with Section 16222, Electric Motors.
- B. Variable speed drives shall be provided as specified in each pump section and in accordance with Section 16222 - Motors. The variable frequency drive controller and components shall be housed as shown on the Drawings and specified in each pump Section. Pump Supplier shall coordinate with VFD Supplier to ensure pump and VFD compatibility.

2.5 SPARE PARTS

- A. Spare parts shall be provided as indicated in the individual pump sections.
- B. The pumps shall be backed by supplies of spare parts from stock, and after-sales service from a factory trained and authorize maintenance facility, located within 500 miles from the installation.
- C. All spare parts shall be accompanied by a packing list and be in a condition acceptable to the ENGINEER or his designated representative. The packing list shall include a detailed listing of each item, including name of equipment, referenced Specification Section and subsection, name of part, manufacturer's name, and cost of item. All spare parts shall be delivered and stored as indicated in Section 01600 – Delivery Storage and Handling.

2.6 PROTECTIVE COATING

- A. General: Materials and equipment shall be coated in accordance with Section 09960 – Protective Coatings and the Contract Documents.

- B. Shop Coating. After shop testing and before shipment, all ferrous surfaces, excluding machined surfaces and nameplates, shall be shop painted.
- C. Field Coating. Field coating shall not be executed until after field testing is completed. Additionally, machined surfaces and nameplates shall not be painted. Color shall be approved by ENGINEER.

2.7 MANUFACTURERS

- A. Manufacturer Experience: Manufacturers shall have had previous experience in such manufacture and shall, upon request of the ENGINEER, furnish the names of not less than 5 successful installations of its equipment of comparable nature to that offered under this contract. All manufactured items provided under this Section shall be new, or current manufacture, and shall be the products of reputable manufactures specializing in the manufacture of such products. The Manufacturer's Qualifications covered in this Section shall be submitted to the ENGINEER.
- B. Unit Responsibility: A single manufacturer shall be made responsible for furnishing the Work and for coordination of design, assembly, testing, and installation of the Work of each pump Section; however, the CONTRACTOR shall be responsible to the OWNER for compliance with the requirements of each pump Section. Unless otherwise indicated, the single manufacturer shall be the manufacturer of the pump. Where two or more pump systems of the same type or size are required, the pumps shall all be produced by the same manufacturer.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. A complete set of manufacturer's instructions covering storage, installation, operation, lubrication, and maintenance shall be furnished to the OWNER no later than the date the equipment is shipped. Care during storage and procedures for installation, lubrication, and startup of the equipment and motors shall be in strict conformance with the manufacturer's instructions.
- B. The CONTRACTOR shall prepare and load all material and articles for shipment in a manner that protects the equipment and coatings from damage in transit, shall include a packing list, and shall be responsible for and make good any and all damage. During shipping the rotating elements shall be suitably supported or disassembled to protect bearings.
- C. Equipment furnished shall be shipped to the site in enclosed, weather-tight, sealed containers in a manner designed to protect the pumping units against damaging stress caused by sudden acceleration or deceleration. For equipment 25 horsepower or greater, two recording accelerometers, designed to record the magnitude of any sudden impact in all three directions (X, Y, Z) on continuous strip charts, shall be shipped with, and fixed to each assembly or its packing container. Upon arrival of each shipment, the accelerometers shall be removed in the presence of representatives of the ENGINEER, the CONTRACTOR, and the equipment manufacturer. If magnitude of the maximum acceleration exceeds 3.0 times the acceleration due to the force of gravity (3.0 g), the assembly or subassembly shall be dismantled and completely inspected. All damage shall be corrected to the complete satisfaction of the ENGINEER before the assembly is

incorporated in to the work. The CONTRACTOR shall bear all costs arising out of dismantling, inspection, repair, and reassembly.

- D. Where necessary, heavy parts or machines shall be mounted on skids or shall be crated, and any articles or materials that might otherwise be lost shall be boxed or wired in bundles and plainly marked for identification. The gross weight shall be clearly marked on all boxes or skidded equipment packages exceeding 200 pounds. All parts exceeding 200 pounds gross weight shall be prepared for shipment so that slings for handling by a crane may be readily attached while the parts are on the car or transport truck. Boxed parts, where it is unsafe to attach slings to the box, shall be packed with slings attached to the part, the slings to project through the box or crate so that attachment to the hoisting equipment can be readily made.
- E. All accessories and spare parts shall be packed separately in containers plainly marked "ACCESSORIES ONLY" or "SPARE PARTS ONLY." All packing materials shall be fire retardant. A packing list, listing the contents of each container, shall be placed in a moisture proof envelope and securely fastened to the outside of the container.
- F. All parts shall be properly lubricated and protected so that no damage or deterioration will occur even during a prolonged delay from the time of shipment until installation is completed and the pumps are ready for operation.
- G. Finished ferrous surfaces not painted shall be properly protected to prevent rust and corrosion.
- H. The finished surfaces of all exposed flanges shall be protected by strong wooden blind flanges.
- I. Each pump shall be properly crated to protect the units against damage during shipment.

3.2 INSTALLATION

- A. Install in accordance with the manufacturer's printed instructions.
- B. Alignment: All equipment shall be field tested to verify proper alignment, operation as specified, and freedom from binding, scraping, vibration, shaft runout, or other defects. Pump drive shafts shall be measured just prior to assembly to ensure correct alignment without forcing. Equipment shall be secure in position and neat in appearance. Pump Alignment to be performed by CONTRACTOR.
- C. Lubricants: The CONTRACTOR shall provide the necessary oil and grease for initial operation for a period of at least one year.
- D. The CONTRACTOR shall accomplish pump installation with assistance from the pump Manufacturer.

3.3 TESTING

- A. General: Provide testing in accordance with Section 01756 Facility Startup.
- B. Factory Testing

1. The CONTRACTOR shall be responsible for all costs associated with inspection and testing of materials, products, or equipment at the place of manufacture, unless specified otherwise.
2. The following tests shall be conducted on each indicated pump system:
 - a. Motors: All motors of sizes 100 hp and larger shall be assembled, tested, and certified at the motor factory and the working clearances checked to insure that all parts are properly fitted. The tests shall be in accordance with ANSI/IEEE 112 - Test Procedure for Polyphase Induction Motors and Generators, and ANSI/IEEE 115 - Test Procedure for Synchronous Machines, including heat run and efficiency tests. All computations shall be recorded and certified and dated copies of the test results shall be furnished.
 - b. Pump Systems: All pump systems shall be tested at the pump factory in accordance with the American National Standard for Centrifugal Pump Tests (ANSI/HI 1.6) or the American National Standard for Vertical Pump Tests (ANSI/HI 2.6) as approved by ANSI and published by the Hydraulic Institute. Tests shall be performed using the complete pump system to be furnished, including the motor. For motors smaller than 100 hp, the manufacturer's certified test motor shall be acceptable. Testing of prototype models will not be acceptable. The following minimum test data shall be submitted:
 - 1) Hydrostatic test data.
 - 2) A minimum of five hydraulic test readings between shutoff head and 25 percent beyond the maximum indicated capacity, recorded on data sheets as defined by the Hydraulic Institute.
 - 3) Pump curves showing head, flow, bhp, efficiency, and NPSH requirements.
 - 4) Certification that the pump horsepower demand did not exceed the rated motor hp beyond the 1.0 service rating at any point on the curve.
 - c. Factory Witnessed Tests: All pumps and motors 125 hp and larger shall be factory-tested as complete assembled systems and may be witnessed by the OWNER and ENGINEER. The CONTRACTOR shall give the ENGINEER a minimum of 2 weeks notification prior to the test. At least 2 weeks prior to the test, CONTRACTOR shall submit for review and approval a copy of the proposed test procedure. All costs for OWNER and ENGINEER shall be borne by the OWNER. Test results shall be submitted to the ENGINEER and no equipment shall be shipped until the test data have been approved by the ENGINEER.
 - d. Acceptance: In the event of failure of any pump to meet any of the requirements, the CONTRACTOR shall make all necessary modifications, repairs, or replacements to conform to the requirements of the Contract Documents and the pump shall be re-tested at no additional cost to the OWNER until found satisfactory.

C. Installation Functional Testing

1. The CONTRACTOR shall bear all costs of the functional tests, including related services of the manufacturer's representative, except for power and water which the OWNER will bear. If available, the OWNER'S operating personnel will provide assistance in functional testing. All equipment and

instrumentation required for the testing shall be provided by the CONTRACTOR.

2. The final adjustments and inspections shall be made by factory-trained and authorized service personnel other than sales representatives, who also shall supervise the installation and test operation. CONTRACTOR shall include in bid, allowance for factory-trained service personnel to adjust all of the said equipment to be installed by CONTRACTOR until this equipment has been tested by the CONTRACTOR and the results of these tests are satisfactory to the ENGINEER or his designated representative.
3. Functional testing will be witnessed by the ENGINEER. The CONTRACTOR shall give notice to the OWNER/ ENGINEER two weeks prior to the scheduled functional field test date.
4. At least 2 weeks prior to the test, CONTRACTOR shall submit for review and approval a copy of the proposed functional test procedure.
5. The following functional testing shall be conducted:
 - a. Electrical and instrumentation tests shall conform to the requirements of the Sections under which that equipment is specified.
 - b. The pumping station shall operate as described under the control strategy outlined in the instrumentation specification.
 - c. A field functional acceptance test shall be made of the entire pumping system, including instruments, controls, alarms, plant control system, control strategy, motors, new pumps, VFDs, existing pumps, and valves, to ensure compliance with the performance specified herein.
6. In the event any pumping system fails to meet the test requirements, it shall be modified and retested as above until it satisfies the requirements.
7. After each pumping system has satisfied the requirements, the CONTRACTOR and Factory Representative shall certify in writing that it has been satisfactorily tested and that all final adjustments have been made. Certification shall include the date of the tests, a listing of all persons present during the tests, and the test data.

D. Operation Performance Testing

1. Where required by the individual pump sections, each pump system shall be performance tested, after installation to demonstrate satisfactory operation without excessive noise, vibration, cavitation, or overheating of bearings. The performance of each pump, motor, and VFD shall be verified.
2. All expenses for conducting the performance testing shall be paid by the CONTRACTOR. All equipment and instrumentation required for the testing shall be provided by the CONTRACTOR.
3. The final adjustments and inspections shall be made by factory-trained and authorized service personnel other than sales representatives, who also shall supervise the installation and test operation. CONTRACTOR shall include in bid, allowance for factory-trained service personnel to adjust all of the said equipment to be installed by CONTRACTOR until this equipment has been

tested by the CONTRACTOR and the results of these tests are satisfactory to the ENGINEER or his designated representative.

4. Performance testing will be witnessed by the ENGINEER. The CONTRACTOR shall give notice to the OWNER/ENGINEER 2 (two) prior to the scheduled test date.
5. At least 2 weeks prior to performance test, CONTRACTOR shall submit for review and approval a copy of the proposed performance test procedure.
6. The following performance testing shall be conducted:
 - a. Startup, check, and operate the pump system over its entire speed range. Vibration shall be within the amplitude limits recommended by the Hydraulic Institute Standards at a minimum of four pumping conditions defined by the ENGINEER.
 - b. Obtain concurrent readings of motor voltage, amperage, pump suction head, and pump discharge head for at least four pumping conditions at each pump rotational speed. Check each power lead to the motor for proper current balance.
 - c. Determine bearing temperatures by contact type thermometer. A run time of at least 20 minutes shall precede this test unless insufficient liquid volume is available.
7. The tests shall demonstrate that the equipment has been properly installed, aligned and connected, is free of mechanical defects, electrical defects, excessive vibration, overheating or overloading, and that the control system performs as specified and meets all operating criteria. All parts shall operate satisfactorily in all respects and in accordance with the specified requirements for the full duration of the test period. If any part of a unit shows evidence of unsatisfactory or improper operation during the test period, correction or repairs shall be made by the CONTRACTOR and the full performance test shall be redone for that unit after all parts operate satisfactorily.
8. After each pumping system has satisfied the requirements, the CONTRACTOR shall certify in writing that it has been satisfactorily tested and that all final adjustments have been made. Certification shall include the date of the tests, a listing of all persons present during the tests, and the test data.

E. Operational Testing

1. Provide testing in accordance with Section 01756 Facility Startup.

END OF SECTION

SECTION 11147 – DOUBLE DISC PUMPS

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall provide double disc pumps and motors with associated piping, controls, wiring, and appurtenances, including v-belt drive arrangement, and motor all completely assembled on fabricated stainless steel base and shall conform to the specification section described herein.
- B. Pumps and accessories specified herein are intended to be direct replacements to units currently installed and operating at this facility. Contractor shall review existing conditions and confirm existing equipment serial numbers and operating data prior to submitting new pumps and accessories for review.
- C. The Contractor is responsible for designing and constructing the replacement North and South Sludge Pump Station and the Digester Sludge Transfer Pump Station in accordance with the Contract Documents. The Contractor shall coordinate final layout plans with the pump manufacturer to provide acceptable access to equipment for installation and maintenance and meet the manufacturer's recommended installation requirements. Pump shall provided with equipment pads and anchorage in accordance with the details provided in the Contract Documents.
- D. The Manufacturer shall review the site conditions, intended application, and operation of the pump system and confirm that the recommended pump will satisfied the indicated requirements.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. ASTM
- B. AWWA
- C. ASME
- D. ANSI
- E. NFPA

1.3 CONTRACTOR SUBMITTALS

- A. General: CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished as required in this Section and in referenced Sections.
- B. Shop Drawings: Complete assembly, foundation, and installation drawings, together with detailed specifications and data covering materials used, drive unit, parts, and devices, and other accessories forming a part of the equipment furnished shall be submitted in accordance with the requirements of Section 01330 Submittals. Detailed specifications of proposed shop-applied coatings and corrosion protection systems for equipment, components, appurtenances, and accessories shall be provided.

- C. Control Diagrams: All proposed control diagrams, installation details, and layouts for all control panels shall be provided.
- D. O & M Manuals: The CONTRACTOR shall provide operators and maintenance data for all equipment furnished for the project in accordance with Section 01730, Operation and Maintenance Data.
- E. Tools: Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the WORK hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.
- F. Contact Information: Contact and pricing information for Suppliers of the double disc pump to be provided. Submit name, address, telephone number, and contact person for the primary equipment Supplier.

1.4 QUALITY ASSURANCE

- A. CONTRACTOR shall submit the following:

- 1. Manufacturer's Certificate of Proper Installation
 - 2. Functional Test Certification
 - 3. Factory performance test reports
 - 4. Special shipping, storage and protection, and handling instructions
 - 5. MANUFACTURER's printed installation instructions
 - 6. List of suggested spare parts to maintain the equipment in service for a period of 5 years.
- 7. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.
- 8. Warranty
- 9. The equipment shall be warranted for a period of two (2) years from against defects in workmanship and materials under normal use. If the equipment should fail during the warranty period due to a defective part, it shall be replaced and the units restored at no expense to the owner.
- 10. Unless otherwise specified in this specification section, the equipment shall be provided with a warranty in accordance with Section 01740 – Warranty.

1.5 MANUFACTURERS SERVICE REPRESENTATIVE

- A. MANUFACTURER's Representative. In accordance with the requirements of Section 01782, Operating and Maintenance Data, a MANUFACTURER's Representative shall be present at the site or classroom designated by the OWNER to provide the services and minimum person-days listed below, travel time excluded.
 - 1. 0.5 person-days for classroom services,

2. 0.5 person-days for start-up and performance testing

PART 2 PRODUCTS

2.1 GENERAL

- A. Pumps shall be designed to reliably pump liquid and primary sludge and scum mixtures from 0% to 10% solids content.

2.2 PUMP PERFORMANCE REQUIREMENTS

- A. The performance requirements of the double disc pumps are shown in Table 1.

Table 1 - Pump Performance Requirements

Primary Sludge Pumps

Pump tag numbers	PC1-PMP-1, PC1-PMP-2
Number of units	2
Material being pumped	Primary sludge and primary scum
Maximum percent solids	10%
Pump capacity, each (GPM)	150
Rated Discharge Head (Feet)	10
Suction & Discharge Diameter	4 inch
Drive Type	V-belt and pulley arrangement
Replaces Penn Valley Pump Serial Numbers	070268-1, 070268-2

Digester Sludge Transfer Pump

Pump tag numbers	DS-PMP1
Number of units	1
Material being pumped	Digested Sludge
Maximum percent solids	10%
Pump capacity, each (GPM)	75
Rated Discharge Head (Feet)	40
Suction & Discharge Diameter	4 inch
Drive Type	V-belt and pulley arrangement
Replaces Penn Valley Pump Serial Number	070268-3

2.3 PUMP COMPONENTS

- A. Housing: Pump shall be a simplex heavy-duty, double disc, positive displacement type, with Class 30 Cast Iron Housings. Pump shall allow access to the internal components without disturbing the pump bodies, valve chambers, or piping. The discharge housing shall contain mounting lugs and be bolted directly to the mounting frame. The discharge, intermediate and suction housings shall incorporate an integral hinge arrangement that allows the suction and intermediate housing to be lowered and removed. The hinges shall be connected to each other with a quick ball detent pin allowing for easy pin removal.
- B. Discs: Pumping action shall be achieved by two (2) reciprocating discs of Grade 65-45-12 ductile iron attached to high tensile aluminum connecting rods driven by a rotating eccentric shaft. The suction and discharge discs shall be universal and interchangeable with each other for commonality of spare parts. The discs shall be of integral design and constructed of high tensile neoprene with multiple layers of fabric for longevity and strength. Each disc shall be mounted to the connecting rod by a stub shaft constructed of hardened high tensile stainless steel. The reciprocating action of the discs shall also perform the duty of valves. Pumps that require internal check valves for operation shall not be acceptable.
 - 1. Trunnions: Sealing of the pump fluid chamber shall be achieved by flexible trunnions. The trunnion construction shall be of fabric-reinforced neoprene and shall be capable of withstanding pressures from 0 to 100 psi on an intermittent basis. Pump designs utilizing packing glands, mechanical seals, or water seal system will not be acceptable.
- C. Neck: The swan neck entry port to the suction housing shall be a two (2) piece design allowing for mounting of the suction connection in 90 degree increments and provide easy access for clack replacement. The upper swan neck shall be provided with a 2" NPT connection to allow mounting of the suction pulsation dampener if required. The entry port shall be a full 4" diameter with a minimum opening of 12.56 square inches to minimize debris buildup and blockages. The seating surface for the clack valve shall be machined on the mounting face of the swan neck. Designs that require an individual plate with smaller diameter opening shall not be acceptable. The clack valve shall be integrally mounted to the swan neck to facilitate access and replacement. The clack valve shall be manufactured of neoprene construction with multiple layers of fabric encapsulating a rigid core. The clack valve shall incorporate an integral O-ring seal for positive sealing
- D. Drive Assembly: The bearing drive assembly shall consist of two (2) aluminum modular pedestals designed to provide accurate bearing alignment, superior bearing loading and ease of assembly. The drive shaft shall be a minimum 1-3/8" diameter and capable of withstanding a dead head situation. The shaft shall be constructed of hardened high-tensile stainless steel and shall be mounted on four (4) self-aligning, sealed bearings. The eccentric cams shall be constructed of high tensile, cast bronze alloy and shall be pinned to the shaft by spirol drive pins to allow for the absorption of reciprocating loads generated by the pumping action. Pump drive assemblies that utilize keyways and setscrews will not be acceptable. All drive bearings must be completely sealed with no provisions for scheduled grease lubrication. No grease fittings shall be supplied for the bearings.
- E. Belt: The pump shall be driven through a V-belt and drive assembly consisting of a 2 groove Type B arrangement. The pulley ratios shall be sized to provide the maximum

pump speed listed in the pump schedule in this section and to provide the required torque generated between the pump and motor.

- F. Guards and Covers: Pump shall be provided with OSHA approved guards and covers. The V-belt driver cover and drive assembly cover shall be manufactured from 304SS.
- G. Base: Each pump and V-belt assembly shall be mounted on a common Type 304 stainless steel sub-base. Base design shall have raised cross-members on the suction and discharge end to allow for complete wash-out and draining without trapping liquid. Each sub-base shall be manufactured from 2" Type 304 stainless steel square tubing. Base shall be sufficiently gusseted, reinforced and braced to withstand all shock loads and resist all wearing and buckling during pump operation. Tubing ends shall be capped with black plastic plugs for clean appearance.
- H. Dampeners: Pulsation dampeners shall be provided on the suction and discharge lines. The dampeners shall be 6" diameter Schedule 40 carbon steel pipe with fully welded end caps. The suction dampener shall mount directly to the suction swan neck through the 2" NPT connection. The discharge dampener shall be a separate piece with 4" ASA 150 flanged connections. The dampeners shall be pressure tested to 60 psi for leaks. Each dampener shall be provided with a 1-inch half coupling located at the top. This connection shall be suitable for the vacuum and pressure switch assembly or the ball valve/quick disconnect assembly should a switch not be specified. The discharge dampener shall be supplied with a 1-1/2" NPT coupling and plug in the bottom to act as a drain/sample port. Bladder type and three-piece assemblies using connecting rods and gasket shall not be acceptable.

2.4 CONTROLS

- A. Pump controls shall be supplied per Section 13400 Instrumentation and Control Systems and Section 13475 Control Strategies.

2.5 MOTOR

- A. The motor shall be adequately sized to withstand the loads during startup and pump operation. Motor shall be severe duty, premium efficient, inverter-ready per NEMA STD MG1 Part 31.4.4.2 with epoxy coated cast iron frame. The motor shall be of totally enclosed fan-cooled enclosure designed for continuous operation under full load.
- B. Motor requirements are listed in Table 2 below.

Table 2 - Motor Requirements

Minimum Motor Horsepower	5
Maximum Speed (rpm)	1,800
Voltage	230-460V
Phase	3
Frequency (Hz)	60
Minimum Service Factor	1.15
Motor Enclosure	TEFC

2.6 SUCTION VACUUM PROTECTION

- A. Pump manufacturer shall provide a suction vacuum sensor and switch assembly to mount on the suction pulsation dampener. The sensor shall be a PVP420, Red Valve 42/742 (or equal), 1-inch NPT isolation pressure sensor with Type 316 stainless steel body and EPDM elastomeric sensing tube. The process pressure is sensed through the 360- degree elastomeric tube and glycerin transfers pressure to the gauge and switch. The gauge and switch shall be attached to the sensor with Type 316 stainless steel fittings. The vacuum assembly shall be fitted with 4" stainless steel 30"Hg – 30psi gauge and adjustable vacuum switch set at 10"Hg. The units shall be capable of being cleaned in place by simply using the process pressure through a Type 316 stainless steel isolation valve mounted to the top of the sensor. The opposite end of the valve shall be fitted with a universal, quick acting coupling, suitable for compressed air. This valve connection will be suitable to charge the dampener with compressed air.

2.7 DISCHARGE PRESSURE PROTECTION

- A. The pump manufacturer shall provide a discharge pressure sensor and switch assembly to mount on the discharge pulsation dampener. The sensor shall be a PVP420, Red Valve 42/742 (or equal) 1-inch NPT isolation pressure sensor with 316SS body and EPDM elastomeric sensing tube. The process pressure is sensed through the 360-degree elastomeric tube and glycerin transfers pressure to the gauge and switch. The gauge and switch shall be attached to the sensor with 316SS fittings. The discharge assembly shall be fitted with a 4" stainless steel 0-100 psi pressure gauge and shall be fitted an adjustable switch preset at 30 psi. The units shall be capable of being cleaned in place by simply using the process pressure through a 316SS isolation valve mounted to the top of the sensor. The opposite end of the valve shall be fitted with a universal, quick acting coupling, suitable for compressed air. This valve connection will be suitable to charge the dampener with compressed air.

2.8 PROTECTIVE COATINGS

- A. Materials and equipment, unless otherwise stated in this Section, shall be coated in accordance with Section 09960 Protective Coatings and the Contract Documents.
- B. All ferrous metal surfaces shall be shop cleaned and degreased. All stainless steel and aluminum surfaces will remain unpainted. All weld splatter shall be removed and all welds ground smooth for a clean appearance.

2.9 SPARE PARTS

- A. The following spare parts shall be furnished as a minimum:

Item	Quantity
Discs	2
Trunnions	2
Set of gaskets	2
Control valve	1

2.10 MANUFACTURERS

- A. Manufacturer, no equal (to match existing equipment):
 - 1. Penn Valley Pump Company, Inc.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. A complete set of MANUFACTURER's instructions covering storage, installation, operation, lubrication, and maintenance shall be furnished to the OWNER no later than the date the equipment is shipped. Care during storage and procedures for installation, lubrication, and startup of the equipment and motors shall be in strict conformance with the MANUFACTURER's instructions.
- B. Pumps shall be delivered to the jobsite in undamaged condition. Pumps shall be stored above ground and protected from the weather.

3.2 INSTALLATION

- A. Install all items in accordance with the printed instructions of the manufacturer, as indicated as specified.
- B. Dowel to frame after alignment in the field to facilitate realignment after disassembly.
- C. Install and align on a concrete pad as specified in the drawings.
- D. Brace all piping at suction and discharge connections to withstand all shock loads and vibration.

3.3 TESTING

- A. General: Furnish labor, piping, equipment, and material for conducting the tests.
- B. Factory Testing: The Supplier shall inspect control panels and equipment for required construction, electrical connection, and intended function.
- C. Functional Testing: Each pump shall be field tested in the presence of ENGINEER demonstrating its ability to operate without vibration or overheating and deliver its rated capacity under specified conditions. Specifically, the following items shall be measured at five (5) points over the entire operating range:
 - 1. Discharge head
 - 2. Suction head
 - 3. Capacity
 - 4. Pump speed
 - 5. Amperage draw
- D. Defects: Correct all defects or replace defective equipment, revealed, and noted during tests. Make necessary adjustments at the time of the tests at the expense of

CONTRACTOR. Repeat tests if necessary to obtain results acceptable to the ENGINEER.

E. Performance Testing

1. Performance testing of the full-scale equipment, unless otherwise stated in this Section, shall be required in accordance with Section 01756 - Facility Startup.

END OF SECTION

SECTION 11231 – CIRCULAR CENTER-FEED CLARIFIER

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall furnish and install one (1) primary circular spiral scraper shaft drive clarifier consisting of sludge collector and skimming equipment complete and operable, in accordance with the Contract Documents.
- B. The equipment shall include a center drive unit and torque control, walkway and platform with handrail and stairs to the cover, center feedwell, rotating drive shaft/influent column, rake arms with spiral blades, anchor bolts, scum skimmer, scum box, effluent weir, scum baffle, and all other appurtenances required or shown on the drawings. Unless otherwise indicated, all materials for the structure and appurtenances shall be Type 316 stainless steel.
- C. The equipment supplied shall be fully coordinated with the clarifier cover to be provided under this Contract in order to contain air flow between the clarifier equipment and the cover. Refer to Section 13130 – Flat Circular Clarifier Cover.
- D. A complete design of the clarifier equipment has been prepared by WesTech, Inc (“WesTech Design”), which is the required supplier for this equipment. This WesTech Design is included as an appendix to this Specification.
 - 1. The WesTech Design is the basis for structural, mechanical, and electrical designs included in the Contract Documents. However, the design presented in the Contract documents has incorporated certain non-structural changes such as the removal of bridge/walkway handrails included in the WesTech Design but not required for this Project and the addition of certain features such as platform stairs that are not present in the WesTech Design. The Contractor shall confirm all measurements and aspects of the existing clarifier structure and obtain and submit an updated WesTech design package for District/Engineer review based on these verified measurements, incorporating the changes reflect in the Contract Documents, and inclusive of all accessory items and requirements of this specification. This updated design shall be submitted in accordance with Section 1.3 of this specification.
 - 2. Engineer has attempted to conform this specification to the approved WesTech Clarifier design that has been installed in the Owner’s North Primary Clarifier (formerly Primary Clarifier No. 2). It is the intent of this specification that the mechanical, electrical and controls design, as well as the hydraulic performance and the operation of all accessories and support systems, reflect the current installation in the North Primary Clarifier.
 - a. Where the requirements of this specification or the details presented in the Contract Documents differ from what has been approved and installed in the existing North Primary Clarifier, the WesTech design shall be consistent with the existing North Primary Clarifier provided that the modifications are suitable for installation in the existing South Primary Clarifier.
 - b. Any proposed modifications to this specification, the details provided in the Contract Documents, or the existing installation at the North

Primary Clarifier shall be documented in the Submittal for this equipment and, where applicable, the Manufacturer shall certify that the proposed modifications provide equivalent performance between the North Primary Clarifier and South Primary Clarifier.

- c. It shall be understood the District intends to operate the North and South Primary Clarifiers in parallel, and it is therefore paramount that the operation of these two clarifiers be equal and compatible. No design modifications to the new South Primary Clarifier mechanism shall be allowed that result in different functionality or operation between the two clarifiers. The final South Primary Clarifier installation shall operate identically to the North Primary Clarifier.
 - d. For reference, the existing North Primary Clarifier is a WesTech COPC2 Model Number 8050 and it was supplied under WesTech Job Number 23214A.
3. The Contractor may assume for bidding purposes that the structural, electrical, controls and mechanical designs included in the Contract Documents will be valid for installation of the final clarifier design.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. American Society of Testing Materials (ASTM):
- B. American Iron and Steel Institute (AISI), Heat Treated Steel Specifications
- C. American Gear Manufacturers' Association (AGMA), Gear Ratings
- D. American Welding Society (AWS), Current Standards
- E. Anti-friction Bearing Manufacturers' Association (AFBMA), Bearing Life Specifications
- F. National Electrical Manufacturer's Association (NEMA), Motor Design Standards and Standards for Control Enclosures
- G. National Fire Protection Association (NFPA)

1.3 CONTRACTOR SUBMITTALS

- A. General: CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished this Section and in referenced Sections.
- B. Shop Drawings and Samples: In addition to the requirements of Section 01330 – Submittal Procedures, CONTRACTOR shall submit the following:
 - 1. MANUFACTURER's calculations substantiating the output torque rating of the complete drive mechanism, including gears and pinions. The calculations shall clearly specify the values used for the following design parameters for surface durability and strength ratings. Calculations shall be stamped and signed by a Professional Engineer licensed in the State of California.
 - a. Number of Pinions
 - b. Actual Face Width
 - c. Tooth Geometry Factor (I & J Factors)

- d. Load Distribution Factor
 - e. Allowable Contact Stress
2. Allowable Bending Stress
- a. Pinion Pitch Diameter
 - b. Tooth Diametric Pitch
 - c. Hardness Ratio Factor
 - d. Elastic Coefficient
 - e. Life Factor
 - f. Worm and Worm Gear Pitch Diameter
3. The load distribution factor shall be determined as described in the referenced AGMA standard above. The net face width for surface durability calculations shall not exceed 90 percent of the actual face width of the narrower of the two mating gears. For parameters which are material dependent, such as allowable contact stress, the calculations shall include a full description of the materials and heat treatments used.
4. Calculations documenting the AGMA rating of the drive unit and life of the main bearing, prepared and signed by a registered professional engineer.
5. Complete descriptive information and electrical schematic for the torque overload device.
6. Complete sludge transport calculations substantiating the rake blade design, rake tip speed, and floor slope.
7. Complete process calculations substantiating the sizing of the center column and ports, and outer feedwell. These calculations shall be based on parameters from the manufacturers operating experience. These parameters shall be verified by data presented from successful operating installations. Side by side comparison testing of feedwell design from existing operating clarifiers that have spiral rake blades and are products of the manufacturer shall be presented with the calculations.
8. MANUFACTURER's product data including catalogue cuts.
9. Complete certified equipment drawings, showing all dimensions, weights, materials of construction, structural members, sludge collection members, welds, torque ratings, and gears.
10. Foundation, installation, and grouting plans.
11. Anchor bolt placement.
12. Type and size of structural details for sludge draw off pipes, where appropriate, including method of return sludge flow control, and all pipe connection details.
13. Skimming device details.
14. Equipment drive and drive guard details.

15. Size, make, and type designation of electric motor, including mounting details.
 16. Type, specifications, detail drawings and information on type, input and output speeds, exact gear ratios, service factor (24-hour continuous service), capacity, and efficiency of gear reducer units and drive assembly and diameter of ball race.
 17. Details and description of the overload protection assembly. Details submitted shall clearly demonstrate the adequacy of the overload protection provided by the assembly proposed. Overload alarm contact shall be provided as shown on the control diagram.
 18. Seismic calculations in accordance with the requirements of Drawing S-1. The calculations shall clearly specify the values used. Calculations shall be stamped and signed by a Professional Engineer licensed by the State of California. Calculations shall be used to verify the structural design presented in the Contract Documents. Existing calculations from the WesTech Design may be submitted if updates are not required by the Engineer of Record.
 19. Certification from the Manufacturer that the design provided will provide functionally identical operation to the existing North Primary Clarifier (See Section 1.1 D).
 20. O & M Manuals: The CONTRACTOR shall provide operators and maintenance data for all equipment furnished for the project in accordance with Section 01782, Operating and Maintenance Data. The manual shall include the supplier's erection and assembly recommendations and a complete list of recommended spare parts.
- C. Tools: Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the WORK hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

1.4 QUALITY ASSURANCE

- A. CONTRACTOR shall submit the following:
1. MANUFACTURER's Certificate of Proper Installation
 2. Functional Test Certification
 3. Factory performance test reports
 4. Special shipping, storage and protection, and handling instructions
 5. MANUFACTURER's printed installation instructions
 6. List of suggested spare parts to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance.
 7. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.

B. Warranty

1. A written suppliers warranty shall be provided for the equipment specified in this section as required in Section 01785 Warranties and Bonds.
2. A written supplier's warranty shall be provided for the equipment specified in this section. The warranty shall be for a minimum period of five (5) years from start up or 66 months from time of equipment shipment, whichever comes first. Such warranty shall cover all defects or failures of materials or workmanship which occur as the result of normal operation and service except for normal wear parts (i.e. squeegees, skimmer wipers, etc.).

1.5 MANUFACTURERS SERVICE REPRESENTATIVE

- A. Manufacturer's Representative. In accordance with the requirements of Section 01782, Operating and Maintenance Data, a Manufacturer's Representative shall be present at the site or classroom designated by the OWNER to provide the services and minimum person-days listed below, travel time excluded.
1. 1 person-days for installation assistance and inspection,
 2. 1 person-days for functional and performance testing
 3. 1 person-days for pre-startup training of OWNER's personnel.

PART 2 PRODUCTS

2.1 GENERAL – PC1 (SOUTH PRIMARY CLARIFIER)

- A. Refer to Section 1.1 D for general notes and requirements regarding the WesTech Design and compatibility and consistency with the approved design of the existing North Primary Clarifier mechanism by WesTech, Inc.
- B. The clarifier mechanism shall be of the center-drive type, mounted on a structural bridge which spans the tank and bears on the wall at each end. Flow shall enter the feedwell through ports in the rotating drive shaft/influent column. The clarifier shall be designed to remove settled sludge from the bottom of the tank and floating scum from around the periphery of the tank. The clarifier mechanism shall be furnished and installed complete with all supports, electric driveheads, sludge collector, mechanical equipment, electrical work, and appurtenances ready for operation. All mechanisms or parts shall be amply proportioned for the stresses which may occur during operation or for any other stresses which may occur during fabrication and erection. Guards shall be furnished for all exposed moving shafts, drives, or parts as required by the applicable safety codes. All main drive assemblies shall be provided by the equipment MANUFACTURER.
- C. The clarifier shall perform the following integrated functions:
1. Dissipate energy and control localized currents.
 2. Separate solids form the clear liquid.
 3. Evenly withdraw the clear liquid.
 4. Transport and thicken settled sludge.

5. Remove scum from the clarifier surface.
- D. The drivehead torque shall be defined in Section 2.2. The gear teeth shall not be stressed to more than allowed, according to the referenced AGMA Standard, at a load equivalent to a value of the momentary peak (stalled) torque. The entire mechanism shall be capable of withstanding an impact load of the momentary peak (stalled) torque, without sustaining damage or permanent deformation. The 20-year maximum continuous running torque shall be a computed value according to the referenced AGMA standard below.
- E. Workmanship and Design: All parts of the equipment shall be amply proportioned for long, continuous, uninterrupted service. Provision shall be made for easy access for service or replacement of parts. Corresponding parts of multiple units shall be interchangeable. Workmanship shall be first class, with all welding in accordance with the latest applicable edition of the "Structural Welding Code", AWS D1.1, (AWS D1.2-Aluminum, AWS D1.6-Stainless Steel), of the American Welding Society. All welded connections shall develop the full strength of the connected elements and all joined or lapped surfaces shall be completely seal welded with a minimum 3/16" fillet weld. Intermittent welding shall not be allowed, except on non-ferrous metals. Sharp corners of cut or sheared edges which will be submerged in operation shall be dulled by at least one pass of a power grinder to improve paint adherence. Welds on submerged surfaces and edges shall be of the continuous type. The complete drive mechanism shall be designed for the maximum continuous running torque per AGMA 908-B and 2001-B for a minimum life of 20 years or 175,000 hours, unless otherwise specified, and a momentary peak (stalled) torque of twice the maximum continuous running torque. The maximum allowable stresses on structural steel members shall not exceed those permitted by the latest AISC specifications for applicable design, at twice the maximum continuous running torque.
- F. The equipment specified herein shall be factory assembled as far as practical to verify that all mating parts can be field assembled. All mating parts shall be trial fit and match marked. The manufacturer shall submit certification of shop trial assembly and photographs of assembly before shipment. The customer and installation contractor shall be given the opportunity to witness the shop assembly.
- G. Shop inspection shall be performed by a qualified inspector and certified by the manufacturer. The inspection shall be documented and all deficiencies noted, corrected, re-inspected and final completion formally authorized. Final shipment authorization shall be by the manufacturer to ensure completion of all fabrication, assembly, and inspection requirements. Inspection records and evidence of inspector qualification shall be submitted to the owner upon request.

2.2 PERFORMANCE REQUIREMENTS

Influent Flow, Total: (mgd)	
Design (avg. flow)	1.3
Maximum (max. daily flow)	4.0
Peak (peak hourly flow)	13.0
Torque (ft.-lbs.)	
Design running	16,500
Momentary peak	33,000
Overflow: (gpd/sf)	
Minimum	210
Average Dry Weather	631
Peak Day Wet Weather (1 Unit in Service)	2,525
Peak Instantaneous Wet Weather (2 Units in Service)	2,736
Tank Diameter (ft)	55 (Field Verify)
Side Water Depth (ft)	9.5 (Field Verify)
Freeboard (in)	33 (Field Verify)
Bottom Slope (in/lf)	1 (Field Verify)
Walkway, width (ft)	3
Drive shaft/influent column diameter (in)	24
Flocculating Feed Well Dia. (ft)	14
Flocculating Feed Well Depth (ft)	5
Weir V-notch depth (in)	3
Weir V-notch spacing (in on center)	8
Scum box width (ft.)	2.5
Scum Baffle Depth (in)	18
Scum Drain, dia (in)	6
Motor (HP)	1

Motor, maximum (rpm)	1,800
Sludge Arm Tip Speed, min (fpm)	8
Sludge Arm Tip speed, max (fpm)	10
Max continuous running torque (ft/lb)	19,000
Momentary peak (stalled) torque (ft/lb)	50,000
Drive overturning moment (ft.-lbs.)	250,000
Drive Rotation	Clockwise

2.3 CENTER DRIVEHEAD

- A. The drive unit shall be designed and manufactured by the clarifier equipment supplier to ensure unit responsibility. The center drivehead for the Primary Clarifier shall be designed for the torque values listed in the Performance Requirements. It shall turn the mechanism at the design collector tip speed. The drive main bearing shall be designed for the total rotating mechanism loads with a minimum L 10 life of 50 years or 438,000 hours. The drivehead shall be able to produce and withstand the momentary peak (stalled) torque listed in the supplemental data sheets, while starting. The continuous torque shall be defined as the minimum torque at which the drive mechanism may operate continuously 24 hours per day, 365 days per year, for 20 years, at the specified sludge collector arm speed. The center drivehead gear shall be designed to a minimum AGMA 10 rating when rated in accordance with the AGMA 2001-D04 AGMA standard. The maximum continuous running torque rating of the complete drive shall be based on the smaller of the two values determined from the above AGMA standard. Gear teeth shall be designed for proper load distribution and sharing. Stub tooth design and surface hardening of the main gear shall not be allowed.
- B. Physical Characteristics: The drivehead shall consist of a removable internal main gear, pinion, secondary worm gear set, support base, and drivehead bearing. The drive shall be mounted on the walkway and support the entire rotating load of the mechanism. The main internal gear shall be fabricated of alloy hardened steel or nodular iron. The main gear shall have a face depth to diameter ratio of 0.15 or greater for nodular iron and 0.07 or greater for alloy hardened steel. The pinion shall be heat treated alloy steel and forged integral with the shaft or shall be alloyed nodular iron. The worm gear shall be of hardened alloy steel, meehanite, or centrifugally cast bronze. All gears shall be fully enclosed and running in oil. Support base for the drive shall be of welded steel to assure rigidity. Oil and dust shields shall be provided. Seals shall contact a machined surface. The drive bearing shall include a hardened replaceable raceway, or it shall be a forged steel precision gear/bearing set, with fully contoured raceways. Raceway liners, if used, shall be either temperature drawn or bearing quality steel, heat-treated to minimum 40 Rc. An oil sight glass shall be provided for the upper and lower oil reservoirs. Balls shall be grade 500 and heat treated to 60 Rc. Readily accessible lubricant fill and drain pipes with necessary fittings shall be provided.
- C. Turntable: The turntable base shall have an annular raceway for a ball race upon which the rotating assembly rests. It shall have a maximum allowable deflection of

0.024 inches with an allowable modulus of elasticity of 25×10^6 psi when fabricated from steel and 17×10^6 psi when cast iron. The center cage and sludge collection arms shall be fastened to and hung from the gear casing. Ball bearings shall be of the finest quality high carbon, chrome alloy steel balls running in renewable heat-treated alloy steel races mounted in the turntable base and in the gear casting, or in fully contoured races, as part of a precision gear bearing set. The balls shall run in an oil bath which shall be protected by a felt seal and steel dust shield. The oil baths shall be provided with a fill pipe, plug, sight gage indicator, and drain plug.

D. Speed Reducing Unit:

1. The speed reducing unit shall consist of cycloidal, helical, or planetary speed reducers directly connected to a motor without the use of chains or v belts.
2. The main ring gear of cycloidal drives shall be made of high carbon chromium bearing steel and be fixed to the drive casing. An eccentric bearing on the high-speed shaft shall roll cycloidal discs of the same material around the internal circumference of this main ring gear. The lobes of the cycloid disc shall engage successively with pins in the fixed ring gear. The movement of the cycloid discs shall be transmitted then by pins to the low speed shaft. Speed reducer efficiency shall be a minimum of 90% per reduction stage.
3. Speed reducer helical or planetary gearing shall be manufactured to AGMA standards and shall provide at least 95% power transmission efficiency per stage. The speed reducer shall have a minimum service factor of 1.25 based on the output torque rating of the drive.
4. The reducers shall be fitted with radial and thrust bearings of proper size for all mechanism loads and be oil or grease lubricated. As a safety feature, the speed reducer shall be back drivable to release any stored energy as the result of an over torque condition.

E. Motor: Power supply to the equipment shall be 480 volt, 60Hz, 3-phase, unless otherwise indicated. The motor shall be an 1800 rpm synchronous speed, squirrel cage, induction type, totally enclosed fan-cooled, ball bearing heavy duty unit of ample power for starting and operating the mechanism without overload, with a minimum service factor of 1.15, all in accordance with Section 16222. The motor shall be not less than 0.5 HP and the connected load shall not exceed 85 percent of the motor nameplate horsepower rating under any anticipated operating condition. Motor shall be suitable for explosion proof class 1 div 1 per NEC.

F. Center Drive Platform:

1. A center drive platform of 10'-5 x 9'-0 shall be provided. It shall consist of 1/4-inch aluminum checkered plate with necessary stiffeners and supports and provided with connections to the walkway. The entire platform shall be surrounded by handrails 42 inches high of double row 1 1/2-inch diameter horizontal aluminum pipe with 4 inch high kickplates.
2. To meet the electrical code, the center platform shall provide not less than 2.5 feet of working clearance around the drive unit and all auxiliary equipment shown on Contract Documents.

3. Manufacturer shall provide stair access from clarifier cover to platform. Stair loading shall bear on the clarifier platform and not on the cover. For cover maintenance, stairs shall be removable through the use of bolted or similar connections.

G. Bridge Supports

1. Bridge shall be supported by the tank wall at its outer ends and shall be designed to safely withstand a live load of 100 pounds per square foot and all seismic loads as previously defined in the WesTech Design. Deflection shall not exceed $L/360$ when both the dead load and live loads are applied. It shall consist of two beams with 1 1/4-inch aluminum I-bar grating between the beams. The bridge shall be diagonally braced against lateral movement, and provided with handrails 42 inches high, of double row 1 1/2-inch diameter horizontal aluminum pipe, and 4-inch-high kickplates on both sides. Clarifier manufacturer shall coordinate walkway to tank cover interface with tank cover manufacturer to provide an air tight interface.
2. Bridge walking surface shall be tightly installed to form an integral part of the sealed cover design for the clarifier.
3. It is not necessary for the bridge section to act as a maintenance walkway, and no handrails shall be provided for the bridge section.
4. Stainless steel bearing plates, UHMW-PE slide plates, and anchor bolts for the wall support shall be provided by the equipment supplier and installed by the contractor. Bearing plate dimensions and anchor bolt diameter, length, quantity, and arrangement shall be per the equipment supplier. The contractor shall block out or otherwise modify the tank or support structure to accommodate bridge and supports, if required.

2.4 INFLUENT COLUMN, CENTER CAGE, AND FLOCULATING FEEDWELL

A. Rotating Center Drive Shaft/Influent Column

1. A rotating 24-inch diameter steel drive shaft/influent column of minimum schedule 20 pipe shall be provided. The shaft shall be suspended vertically from and receive its rotational power from the center drive unit mounted on the operating platform. The shaft shall extend down to an influent nozzle covering the influent opening in the tank floor. The influent nozzle shall be fastened to the tank floor using a mounting plate and anchor bolts.
2. The shaft shall include a minimum of four (4) influent ports appropriately sized to allow unrestricted passage of the flow into the feedwell.
3. The shaft shall be provided with connections for the two sludge rake arms and feedwell supports. The shaft shall be bolted to the drive unit which shall rotate the shaft with the attached arms and feedwell. The shaft and each arm shall be designed to withstand all torque and seismic loads as previously defined in the WesTech Design.
4. The rotating shaft shall have adequate structural strength to support the entire rotating mechanism, including rake arms, scum scraper and support, scum skimmer, and feedwell.

5. Influent velocity shall not exceed 1.0 fps at the average day flow rate specified.

B. Flocculating Feedwell:

1. A 9-foot x 4.5 foot flocculating feedwell shall diffuse the liquid into the tank without disturbance or formation of velocity currents. Baffled openings shall be provided near the water surface to allow scum to exit the feedwell.
 - a. The supports for the feedwell shall be supported from the shaft. The diameter, depth, detention time, and exit velocities shall match the process application calculations as evidenced by the required successful operating installations.
 - b. The feedwell shall include a 316 SS frame with 1/8" minimum thickness FRP panels. The FRP panels shall be designed to break away from the feedwell frame to reduce the transfer of loads due to sloshing to the rest of the clarifier mechanism.
2. A minimum of eight (8) scum ports, 6 inches high x 16 inches long, shall be provided equally spaced around the feedwell periphery to allow scum to exit from the feedwell at water level. Scum ports shall be free to allow scum to escape; as an alternate to scum ports, the feedwell rim may be submerged slightly below average liquid level to allow floating material to exit the feedwell area. Elevations of these openings shall be coordinated with weir elevations to allow scum to exit feedwell at all flow rates.

2.5 SLUDGE COLLECTION ARMS

A. Sludge Collection Arm

1. The primary clarifier mechanism shall include two (2) full radius sludge rake arms of steel truss construction with spiral-shaped steel scraper blades and adjustable 20 gauge 316 stainless steel squeegees, secured to the blades by Type 316 stainless steel fasteners. The squeegees shall project 1-1/2 inches below the bottom of the rake blades. The blades shall rake the heavy sludge to the center sludge hopper.
2. The truss members and rake blades shall be of adequate size to withstand twice the continuous running torque and be capable of raking any normal sludge deposit encountered without distorting the truss arms or the center cage. If rectangular box construction is used, bracing shall be provided in each and every bay where the truss members meet. If members are placed back to back, there shall be a space between them of at least 1/2-inch.
3. The rake blades shall consist of a minimum 3/16" thick 316 stainless steel plate blade. The blades shall be constructed to a logarithmic spiral curve with a constant 30-degree angle of attack. Blade depth shall vary from 9 inches deep at the outer portion of the rake arm, to 27 inches near the tank center. Each rake truss support arm shall be provided with the necessary outrigger bracing and other blade support structures to ensure that the complete blade can be properly located and adjusted in the field. The structural calculations for the rake arm shall include an analysis of the torsional loads from the spiral curve blade. The cage and rake arms shall be designed such that calculated stresses do not exceed the AISC allowable at twice the drive 100% rating.

4. Scraper blades shall be designed for sufficient sludge transport capacity to handle the design solids loading rate, with the depth of the blade varying from a minimum at the tank periphery to a maximum at the tank center.
5. The rake speed shall be sufficient to transport the necessary volume of sludge to the sludge outlet but shall not re-suspend settled sludge.

2.6 SCUM SKIMMER, SCRAPER, AND SCUM BOX

A. Scum Skimmer

1. Provide skimming devices as part of each clarifier mechanism. Each mechanism shall be furnished with two (2) skimming arms which shall be arranged to sweep the surface of the clarifier, automatically removing scum and floating material into a scum box at the periphery of the tank.
2. The skimming system shall be designed, constructed, and installed to effectively capture and remove scum. Once installed, the system shall be tested and adjusted to provide proper operation. The system shall operate without jerking or losing the accumulated scum. Any modifications to the skimmer, scum box or scum scraper required to obtain proper operation shall be performed by the CONTRACTOR at no additional cost to the OWNER.
3. The rotating scum skimmer shall include a horizontal steel plate skimmer blade supported by vertical steel members extending up from the rake arms. The blade shall extend from a point 6 inches away from the influent feedwell to the hinged scum skimmer assembly at the tank periphery.
4. The skimmer blades shall be constructed using a vertical steel plate, reinforced as necessary to ensure adequate stiffness to maintain contact with the stationary anti-rotational baffle. The skimmer blades shall be attached to the rake arms and shall be oriented so that the interior end is essentially tangent to the flocculation well. An anti-rotation scum baffle shall be provided to improve the collection of surface scum. The skimmer blades shall angle back from the outside of the flocculation well to the center of the rake arm to force the scum to the tank periphery.

B. Scum Scraper:

1. A hinged scum skimmer assembly shall be mounted on the outer end of the skimmer blade. The hinged scum skimmer assembly shall be designed to form a pocket for trapping the scum. The hinged arrangement shall insure continual contact and proper alignment between wiper blade, scum baffle, and ramp as the blade travels up the scum box ramp. The wiper blade shall have a wearing strip on its outer end which contacts the scum baffle and a neoprene strip on its lower and inner edge. The neoprene shall be at least 1/4-inch thick and shall be installed with minimum projection from the steel scraper blade. The scum is trapped as the wiper blade meets the ramp and is raised up the ramp to be deposited into the scum trough for disposal.
2. The hinged scraper shall be counter weighted to provide adjustment. Spring-operated mechanisms are not acceptable. The scraper shall be equipped with adjustable neoprene wiper blades on the bottom and ends of the scraper blade. The neoprene wipers shall be continuous and shall be of sufficient stiffness to maintain contact with the scum box and scum baffle and prevent loss of scum.

C. Scum Box:

1. The scum box shall be 3 feet, supported from the tank wall and shall be connected to the scum sump by a scum pipe. It shall be made of minimum ¼ inch thick welded stainless steel plate. The box shall have a scum trough, vertical 316 stainless steel sides, and a sloping approach ramp that extends from 1-1/2 inches above water level to 5-1/2 inches below. A similar ramp shall be provided at the opposite end to allow the skimmer blade to lower back to the operating position. A flexible connector shall be provided for connection to the contractor supplied scum withdrawal piping in the tank wall. The scum box shall be 6'-0" wide.
2. The scum box design and location shall ensure that the scum on the surface of the tank is captured by the skimmer blade and conveyed by the scissoring action of the anti-rotational baffle to the scum box without losing the accumulated scum. The scum box shall be designed so that the skimmer smoothly enters the scum box, traps the scum in the accumulation area, and lifts the scum up the beach and into the scum trough without jerking or losing the accumulated scum. The exit ramp shall provide a smooth return of the skimmer to its normal operational position.
3. A 6-inch outlet shall be provided on the scum box for the scum discharge pipe. A 6-inch diameter pipe and flexible connector shall be provided to connect the scum box to the scum outlet pipe in the tank wall.

D. Scum Flushing Valve

1. A valve shall be attached to the scum box which automatically opens and allows clarified liquid into the scum box to flush out solids. The valve shall actuate at every pass of the scum skimmer over the scum box, allowing sufficient delay after deposit of the solids before flushing begins. Delay and flush duration shall be adjustable. The opening and closing of the scum flushing valve shall be one smooth continuous movement. The valve shall provide 2 to 5 gallons of flush water per each pass of the skimmer assembly.

2.7 CLARIFIER ACCESSORIES

- A. General: MANUFACTURER shall coordinate the Effluent Weir and Scum Baffle design and installation requirements with the clarifier mechanism, scum box and launder effluent channel and clarifier cover configurations.

B. Effluent Weirs and Scum Baffles

1. General: Provide and install fiberglass weir plates, scum baffle plates, and scum baffle supports as shown on the plans. Included shall be necessary butt and splice plates at each weir and baffle plate joint to prevent short circuiting. All hardware shall be type 316 stainless steel unless otherwise specified.
2. Materials
 - a. Resin: the resin shall be commercial-grade polyester thermosetting resin, appropriate for wastewater applications. The resin shall contain no fillers or additives except a thixotropic agent (up to 5 percent by weight) for viscosity control and pigments which are light stable, not soluble in water, and compatible with the resin.

- b. UV Resistance: ultraviolet stabilizers are required in all laminates exposed to ultraviolet light, pigmentation or ultraviolet absorbers are acceptable.
3. Finish and Appearance: Plates shall have uniform, smooth, resin rich surfaces and shall be free of voids and porosity, without dry spots, crazes or unreinforced areas. All plates shall have a glass content of not less than 30% by weight.
4. Minimum Physical Properties: MANUFACTURER shall furnish certified test reports of the physical and mechanical properties of the product. Each panel shall have the following minimum physical properties.

Tensile Strength	12,000 psi per ASTM D 638
Flexural Strength	20,000 psi per ASTM D 790
Flexural Modulus	1.4 x 10 ⁶ psi per ASTM D-790
Hardness	Barcol 60 per ASTM D 2583

5. Effluent Weirs: An adjustable weir shall be provided around the periphery of the tank at the water surface for removal of clarified effluent. The weir shall consist of 1/4-inch-thick x 9.5 inches' deep fiberglass sections with 3 inch deep 90 degree v notches at 8 inch intervals. The weir sections shall be curved and fastened to the launder wall with special large washers, anchor bolts, and hex nuts to allow vertical adjustment.
6. Scum Baffle: The baffle shall consist of 1/4-inch-thick x 18 inches deep fiberglass sections. In the area of the scum box the scum baffle shall extend to 24 inches starting approximately 6 feet before and ending 2 feet after the scum box. The baffle sections shall be curved and fastened to the launder wall with adjustable FRP support brackets, stainless steel fasteners, and anchor bolts.

2.8 MATERIALS OF CONSTRUCTION

- A. General: All materials used shall be suitable for service in a moist, corrosive environment, as encountered in water and wastewater treatment plants.
- B. Plates and Structural Members: Except where otherwise specified or shown, all plates and structural members designed for submerged service shall have a minimum thickness of 1/4-inch. All steel plates and structural members shall be Type 316 stainless steel and shall conform ASTM A276. Type 316L stainless steel shall be used for welded components.
- C. Bolts and Nuts: All bolts, nuts, anchor bolts, and washers shall be of Type 316 stainless steel, in accordance with Section 05500, Miscellaneous Metals, as specified for submerged service; they shall be of high strength and sized for the intended purpose. Stainless steel split lock washers or locknuts shall be used on all bolted connections. All bolt heads and nuts shall be hexagonal. Anchor bolts shall be cast-in-place in new concrete

1. Anchor Bolts: All anchor bolts shall be a minimum of 1/2-inch diameter. The equipment supplier shall furnish all anchor bolts, nuts, and washers required for the equipment.
2. Fasteners: All structural fasteners shall be a minimum of 1/2-inch diameter and made of type 316 stainless steel. The equipment supplier shall furnish all fasteners required for the assembly of the equipment.

2.9 CONTROLS

- A. Pump controls shall be supplied per Section 13400 Instrumentation and Control Systems and Section 13475 Control Strategies.
- B. All items installed under the primary clarifier cover shall be rated for a Class I Div 1 hazardous area.
- C. Overload Protection:
 1. Overload Protection: The overload device shall be provided in a local control NEMA 4X (316 SS) corrosive resistant enclosure. The device shall be actuated by torque generated from the main drive, which shall operate two independently adjustable switches (the alarm switch at 100 percent of design running torque and the motor cutout switch at 120 percent of design running torque). Devices that require the worm to float and measure the thrust of the worm gear shall not be acceptable. These two switches shall be factory adjusted to accurately calibrate the alarm torque value and the overload position. A visual torque indicator shall be provided and oriented so that it may be read from the walkway. It shall be calibrated from 0 to 160 percent of design running torque. The secondary housing may not be allowed to rotate or have exposed linkage rods or bars to activate the torque device.
 2. A shear pin device, set for 140% of the AGMA rated torque, shall be furnished. The shear pin shall be selected to break when the load on the mechanism achieves 140% of the maximum continuous operating torque specified. A NEMA 4X limit switch shall be provided to activate when the shear pin breaks.
 3. High Torque Alarm Light: Provide a 120 volt, weatherproof, electronic flasher or rotating amber beacon, common alarm light mounted to the clarifier control panel.
 4. High Torque switch: Switches in a weatherproof enclosure shall be provided to actuate an alarm at 85 percent of maximum continuous running torque and to shut down the motor at the maximum continuous running torque. These switches shall be accurately factory calibrated and adjusted to twice the maximum continuous running torque.
- D. Scum Box Spray Assembly:
 1. A limit switch shall activate a solenoid valve and scum trough spray system as the skimmer arm approaches. The scum box spray assembly including the limit switch, spray nozzle, solenoid valve, etc., shall be provided by the MANUFACTURER.
- E. Clarifier Local Control Panel:

1. The equipment supplier shall furnish the clarifier controls housed in a single NEMA 4X, wall-mount, 304 stainless steel enclosure with painted steel back panel, and mounting foot kit. The control panel shall be provided with a local/off/remote switch, run light, rake cutout light, alarm silence, and reset pushbuttons. A thermal magnetic combination motor starter with internally reset thermal overloads, control relays, timers, terminal blocks, fuses and fuse blocks and other supporting hardware shall be provided. A control power transformer shall be included to provide 120VAC for internal controls. The transformer shall have both primary legs and one secondary leg fused.
2. A top mounted, amber strobing alarm light and horn shall provide indication of a high torque condition. A door mounted reset pushbutton shall be provided that clears all interlocks after the high torque conditions have been removed.
3. The control panel shall be wired to accept a single 480VAC, 3 phase, 60 Hertz power feed. A 3 pole molded case circuit breaker with pad-lockable disconnect handle shall be provided for short circuit protection. The contractor shall supply and install all other electrical items required to place the equipment into service.
4. The contractor shall supply and install all field wiring required including but not limited to proper size wire, conduit, fittings, and supports.
5. Clarifier Local Control panel shall be suitable for wall mounting with all required internal devices such as motor starter, control relays, fuses, transformer etc. as a complete UL 508 approved assembly. Provide nameplate as per DIV 13. Each control device such as limit switches, torque switches etc. when connected to the control panel shall be provided with an intrinsically safe relay located in the control panel for compliance with National Electrical Code.
6. Control Functions of the clarifier shall be as specified in DIV 13.

2.10 SPARE PARTS

- A. 1 set - all bearings and bearing seal rings for drivehead, except the main turntable bearing
- B. 1 set - all gaskets for drivehead
- C. 1 set - spur gear sea
- D. 1 set - shear pins
- E. 1 set - any special tools required to assemble, disassemble, or maintain the equipment
- F. Lubricants for one year's operation.

2.11 PROTECTIVE COATING

- A. All ferrous metals and aluminum in contact with other metal or concrete shall be painted in accordance with Section 09960, Protective Coatings.

2.12 MANUFACTURERS

- A. MANUFACTURER'S Experience:

- B. Unit Responsibility: All equipment components of the clarifier mechanism including the center column, influent dispersion well, flocculating well, center drive cage, sludge collector arms, scum skimming system, center drive mechanism, drive motor, electrical controls, local control panel and overload devices and alarms, shall be furnished by the same MANUFACTURER. Some equipment may require modification from the MANUFACTURER's standard.
- C. Manufacturers or Equal:
 - 1. WesTech Model CLS16, as presented in the WesTech Design.

PART 3 EXECUTION

3.1 GENERAL

- A. The equipment shall be fabricated, erected, assembled, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment MANUFACTURER as accepted by the ENGINEER. All units shall be lubricated in strict accordance with the MANUFACTURER's instructions.

3.2 DELIVERY AND STORAGE

- A. A complete set of MANUFACTURER's instructions covering storage, installation, operation, lubrication, and maintenance shall be furnished to the OWNER no later than the date the equipment is shipped. Care during storage and procedures for installation, lubrication, and startup of the equipment and motors shall be in strict conformance with the MANUFACTURER's instructions.
- B. Fabricated assemblies shall be shipped in the largest sections permitted by carrier regulations, properly match-marked for ease of field erection.
- C. All components shall be erected immediately upon receipt from the clarifier MANUFACTURER or stored in strict conformance with storage recommendations provided by the clarifier MANUFACTURER in the operations and maintenance manual.
- D. The mechanism shall be lubricated in strict accordance with the instructions of the clarifier MANUFACTURER's field service representative. The required lubricants shall be provided by the CONTRACTOR.

3.3 INSTALLATION

- A. Install in accordance with the MANUFACTURER's printed instructions.
- B. Grouting the Primary Clarifier Tank Floors : After the equipment has been erected, a 2-inch layer of grout shall be applied to the tank floor, using screeds installed on the mechanism rake/suction arms to form the finished surface. Grouting shall not be done until the mechanism has been inspected by the MANUFACTURER. To prepare the base slab, acid etch and apply epoxy bonding agent per Section 03600, Grout. Preparation of the base slab surface shall be accepted by the CONSTRUCTION MANAGER prior to grouting. Grouting procedure and the grout mix shall be as recommended by the MANUFACTURER, in accordance with Section 03360 and as accepted by the ENGINEER. The grout mix shall be sand and cement, and in no event shall the mix contain aggregate.

3.4 TESTING

- A. General: After installation of the equipment and after completion of the services of the MANUFACTURER's representative, and when plant influent is available, the CONTRACTOR shall operate each unit to demonstrate its ability to operate continuously without vibration, jamming, or overheating and to perform its specified functions satisfactorily. Any defects shall be corrected promptly, or defective equipment replaced. All final adjustments necessary to place the equipment in satisfactory working order, including leveling of the weir with reference to the liquid in the tank, shall be made at the time of the above test.
- B. Functional Testing
 - 1. Torque Tests: The entire sludge collector mechanism shall be statically load tested by loading the rake arm with 120 percent of the specified design running torque. The test shall verify the torque overload control device settings for alarm and motor cutout. One truss arm shall be anchored and the load measured to demonstrate the rake arms,' shaft's, and drive unit's ability to withstand the specified torque. Sketches and calculations shall be submitted illustrating how the torque will be applied prior to the test taking place.
 - 2. Operation Tests: The contractor shall operate the mechanism in a dry tank for a minimum of 4 continuous hours before flow is allowed to enter the system. There shall be no binding, jerky, or unusual motion exhibited during this run-in period. Motor amperage shall be checked at least hourly for any unusual or higher than normal figures. After the unit has successfully passed this initial test, flow shall be introduced into the tank and the same 4-hour observation test run. If the unit should fail under any of these conditions, the test shall be halted and the problem corrected. If, after several attempts, the unit does not successfully pass the field test, the faulty portion of the equipment shall be repaired or replaced and the test re-run.
 - 3. Actual torque versus indicated torque shall be accurately indicated within 7 percent of full scale at all torque readings.
 - 4. There shall be no permanent deformation of any component. If deformation does occur, or correct torque is not achieved, the defective parts shall be replaced by the CONTRACTOR and then retested at no cost to the OWNER.

PART 4 SUPPLEMENTAL ATTACHMENTS

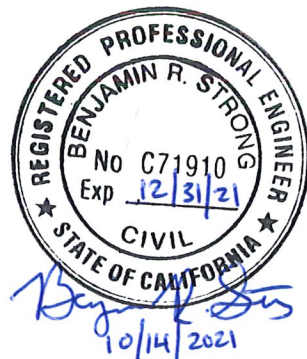
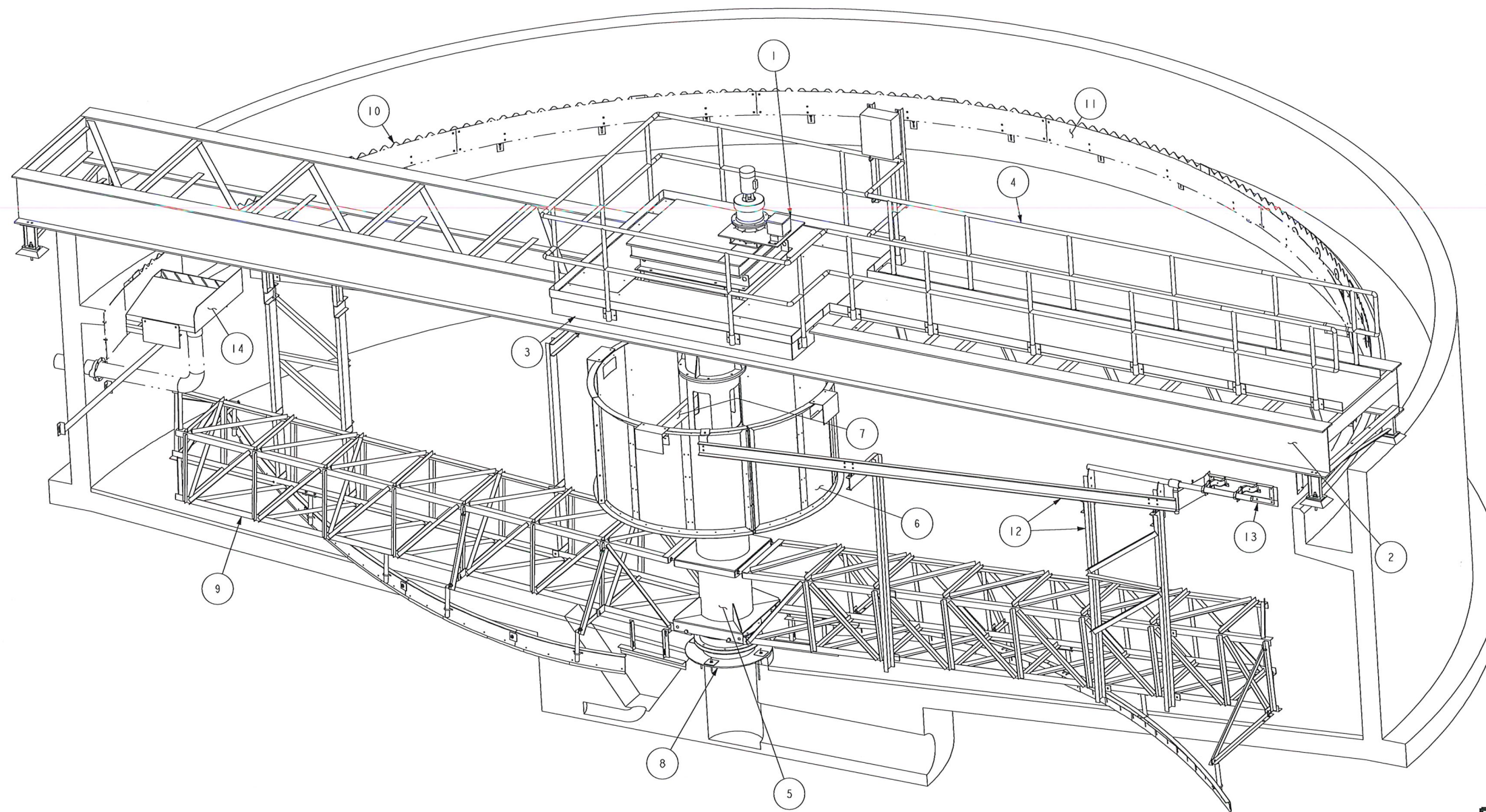
4.1 WESTECH CLARIFIER DESIGN

- A. As described above, the WesTech Clarifier Design Submittal is attached to this specification.

END OF SECTION

WESTECH CLARIFIER DESIGN

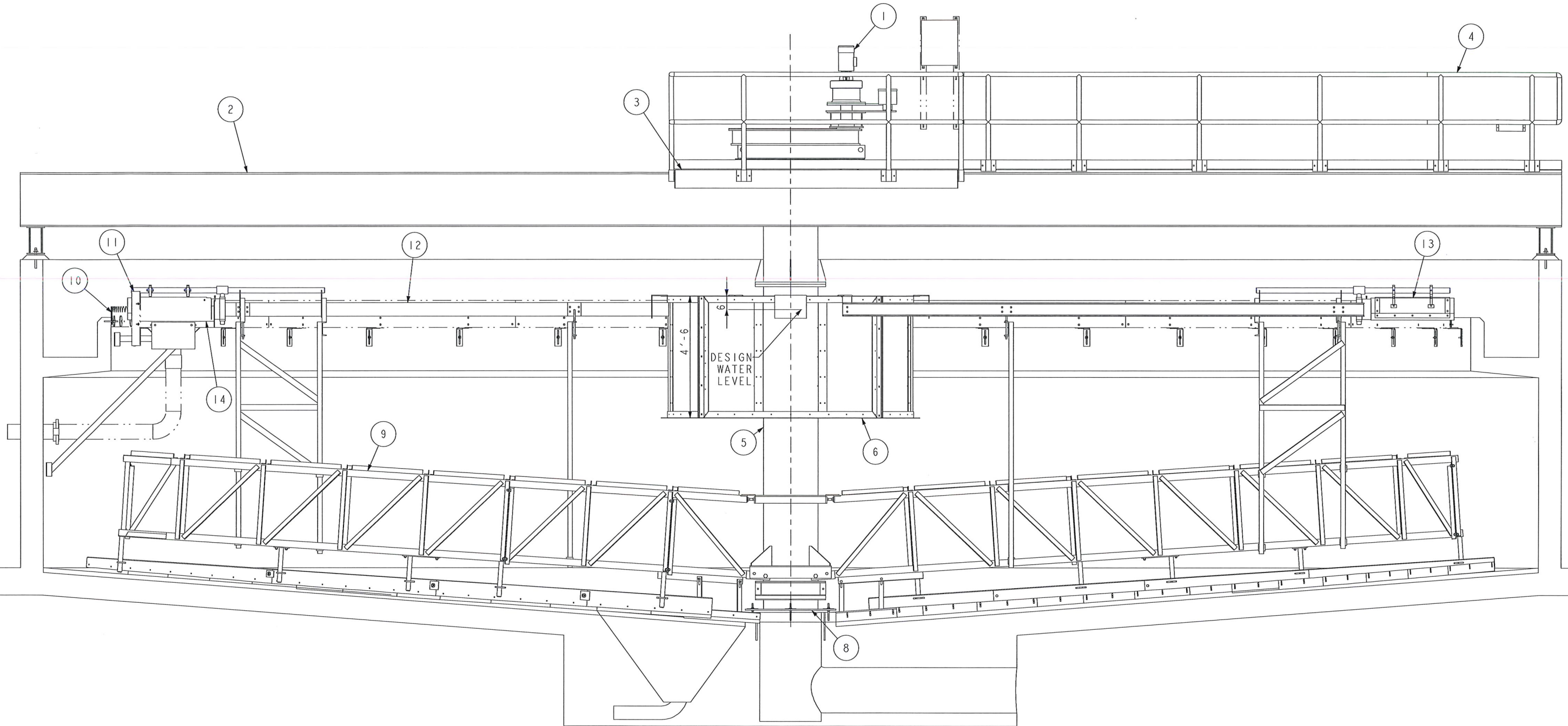
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EQUIPMENT LIST	
ITEM	DESCRIPTION
1	43 IN. DRIVE UNIT WITH TORQUE CONTROL DEVICE 16500 FT-LBS. CONTINUOUS RUNNING TORQUE
2	3'-0 WIDE 316L WALKWAY WITH 1 1/4" ALUMINUM 1-BAR GRATING WITH STRIATED SURFACE
3	10'-5 LONG x 9'-0 WIDE 316L PLATFORM (WITH MINIMUM 2'-0 CLEARANCE AROUND DRIVE UNIT) WITH 1/4" ALUMINUM CHECKERED FLOORPLATE.
4	ALUMINUM HANDRAIL 1 1/2" NOMINAL DIAMETER x 3'-6 HIGH 2-RAIL WITH 4" EXTRUDED KICKPLATE
5	24" DIAMETER SCHEDULE 20 316L CENTER INFLUENT SHAFT
6	9'-0 INSIDE DIAMETER x 4'-6 SIDEDEPTH (316L FRAME) FEEDWELL 1/8" FRP PLATE WITH BAFFLED SCUM PORTS
7	316L FEEDWELL SUPPORTS
8	INFLUENT NOZZLE (316L) 16" WITH MOUNTING PLATE & ANCHOR BOLTS
9	(2) 3'-0 SQUARE RAKE ARMS (316L) WITH SPIRAL BLADES, AND ADJUSTABLE 304SS SQUEEGES.
10	WEIR PLATE (FRP 1/4" x 9" DEEP) WITH 90° V-NOTCHES 2 1/2" DEEP AT 6" INTERVALS (OPTIONAL)
11	BAFFLE FRP 1/4 x 1'-0 DEEP (AROUND TANK) & 2'-0 DEEP (MINIMUM 4'-0 LONG SECTION BEFORE SCUMBOX, MINIMUM 2'-0 LONG SECTION AFTER SCUM BOX & AT SCUM BOX) WITH FRP SUPPORTS.(OPTIONAL)
12	(2) SKIMMER BLADES (316L) WITH SUPPORTS.
13	(2) SCUM SKIMMER ASSEMBLIES WITH NEOPRENE WIPERS
14	2'-6 316L SCUM BOX WITH SUPPORTS AND 6" DISCHARGE PIPE CONNECTION WITH FLEXIBLE COUPLING.
	FLUSHING VALVE (OPTIONAL)
	WALKWAY SUPPORT BRACING
	LIGHT POST WITH MOUNTING BRACKET (OPTIONAL)
	STAIRS (OPTIONAL)
	LADDERS (OPTIONAL)
	PERIPHERAL HANDRAIL (OPTIONAL)
	LAUNDER COVERS (OPTIONAL)
	DENSITY CURRENT BAFFLE (OPTIONAL)
	ELECTRICAL CONTROL PANEL (OPTIONAL)
	TANK COVER (NOT BY WESTECH)

PREPARED FOR: SAUSALITO MARIN CITY WWTP											
ENGINEER:											
CONTRACTOR:											
CUSTOMER P.O. NO.:											
PRIMARY CLARIFIER GENERAL ARRANGEMENT - TANK CUTAWY VIEW											
DESCRIPTION											
COPC2											
55'-0 DIAMETER											
TYPE											
SIZE											
10/00 KDB NONE 07/21 WH17 ME75 CH72											
DATE STD. BY STD. CHKD. STD. APPVD. SCALE DATE PROJ. BY PROJ. CHKD. PROJ. APPVD.											
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DRAWING NUMBER PROJECT NUMBER REV.											
D101 24411A											

316L WAS STL	KW	JM	9/2021
REVISION	BY	CHKD	DATE



10/12/2021



Benjamin R. Strong
10/14/2021

PREPARED FOR: SAUSALITO MARIN CITY WWTP

ENGINEER:

CONTRACTOR:

CUSTOMER P.O. NO.:

PRIMARY CLARIFIER GENERAL ARRANGEMENT - ELEVATION VIEW

DESCRIPTION (CLS:HALF_FINAL_ASSEM) 0.045

COPC2 55'-0 DIAMETER

TYPE SIZE

10/00	KDB			NONE	07/21	WH17	ME75	CH72
DATE	STD. BY	STD. CHKD.	STD. APPVD	SCALE	DATE	PROJ. BY	PROJ. CHKD.	PROJ. APPVD

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Westech

DRAWING NUMBER

D102

PROJECT NUMBER

24411A

REV.

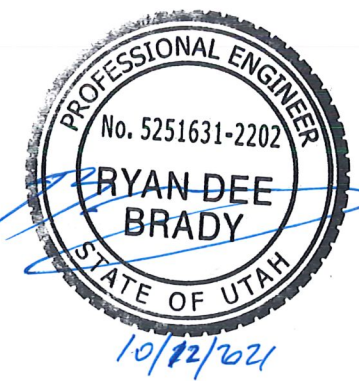
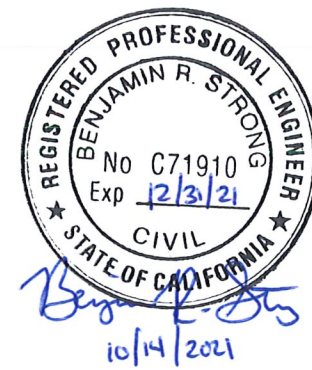
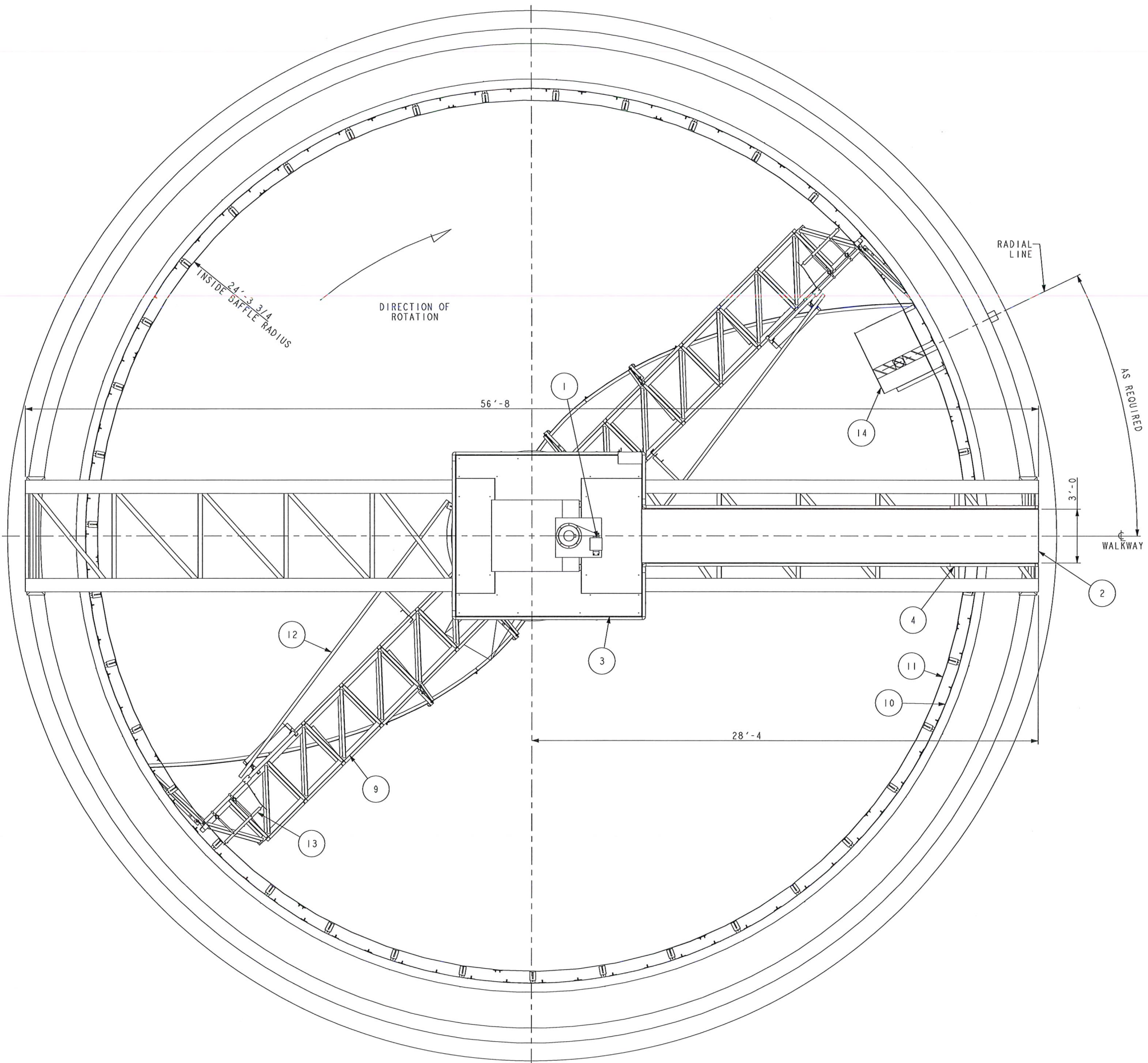
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REVISION

BY

CHKD

DATE



PREPARED FOR: SAUSALITO MARIN CITY WWTP											
ENGINEER:											
CONTRACTOR:											
CUSTOMER P.O. NO.:											
PRIMARY CLARIFIER GENERAL ARRANGEMENT - PLAN VIEW											
DESCRIPTION: COPC2											
SIZE: 55'-0 DIAMETER											
TYPE: 10/00 KDB											
DATE: 10/00											
BY: KDB											
STD. CHKD.: NONE											
STD. APPVD.: NONE											
SCALE: NONE											
DATE: 07/21											
PROJ. BY: WH17											
PROJ. CHKD.: ME75											
PROJ. APPVD.: CH72											
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DRAWING NUMBER: D103				PROJECT NUMBER: 24411A				REV.:			

REVISION	BY	CHKD	DATE
LTR			

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SECTION 13000 INSTRUMENT AND CONTROL SYSTEM

PART 1 GENERAL

1.1 SYSTEM DESCRIPTION

- A. This Section gives general requirements for the instrument and control system (I&CS) which includes primary elements and transmitters, analog display and control elements, discrete display and control elements, control panels, and associated devices.

1.2 RELATED SECTION

- A. Section 13470 PROGRAMMABLE LOGIC CONTROLLER SYSTEM
- B. Division 16 Electrical sections

1.3 SUBMITTALS

- A. Shop Drawings

Shop drawing submittals shall be neatly arranged in 3-ring binders which may have pockets for full-size drawings folded and CD. Tabs shall be used to separate individual items in the submittal. Loose submittals without a binder shall be rejected without review. Deviations if any from the specifications shall be summarized and tabulated on a separate document pages titled "Notes to Reviewer". Shop drawings that do not follow the required format shall be rejected without being reviewed.

1. Bill of Materials: List of required I&CS equipment.
 - a. Group equipment items by common enclosure, and equipment type.
 - b. Data Included:
 - 1) Equipment tag number.
 - 2) Description.
 - 3) Manufacturer, complete model number and all options not defined by model number.
 - 4) Quantity supplied.
2. Catalog Cuts: I&CS Components, Electrical Devices, and Mechanical Devices:
 - a. Catalog information.
 - b. Descriptive literature.
 - c. External power and signal connections.
 - d. Scaled drawings showing exterior dimensions and locations of all electrical and mechanical interfaces.
3. Component Data Sheets: Data sheets for all I&CS components.

- a. Format and Level of Detail in accordance with ISA-S20.
 - b. Specific features and configuration data for each component:
 - 1) Location or service.
 - 2) Manufacturer and complete model number.
 - 3) Size and scale range.
 - 4) Set points.
 - 5) Materials of construction.
 - 6) Options included.
 - c. Name, address, and telephone number of manufacturer's local office, representative, distributor, or service facility.
4. Panel Construction Drawings:
- a. Scale Drawings: Show location of panel mounted devices, doors, louvers, and subpanels.
 - b. Panel Legend: List front of panel devices by tag numbers, nameplate inscriptions, service legends, and annunciator inscriptions.
 - c. Bill of Materials: List devices mounted within panels that are not listed in panel legend. Include tag number, description, manufacturer, and model number.
 - d. Construction Details: NEMA rating, materials, material thickness, structural stiffeners and brackets, lifting lugs, mounting brackets and tabs, door hinges and latches, and welding and other connection callouts and details.
 - e. Construction Notes: Finishes, wire color schemes, wire ratings, and wire numbering and labeling scheme.
5. Interconnection Diagrams: For discrete control and power circuits.
- a. Diagram Type: Ladder diagrams in a format similar to those shown on Drawings. Include devices requiring electrical connections. Show unique rung numbers on left side of each rung where applicable.
 - b. Item Identification: Identify each item with attributes listed.
 - 1) Wires: Wire number and color. Cable number if part of multiconductor cable.
 - 2) Terminals: Location (enclosure number, terminal junction box number, or MMC number), terminal strip number, and terminal block number.
 - 3) Discrete Components:
 - a) Tag number, terminal numbers, and location ("FIELD", enclosure number, or MCC number).

- b) Switching action (open or close on rising or falling process variable), set point value and units, and process variable description.
 - 4) Relay Coils:
 - a) Tag number and its function.
 - b) On right side of rung where coil is located, list contact location by ladder number and sheet number. Underline normally closed contacts.
 - 5) Relay Contacts: Coil tag number, function, and coil location (ladder number and sheet number).
 - a) Show each circuit individually. No "typical" diagrams will be allowed.
 - b) Ground wires and connections.
 - c) Circuit Names: Show names corresponding to Circuit and Raceway Schedule for circuits entering and leaving a panel. Refer to Division 16, ELECTRICAL.
- 6. Loop Diagrams: Individual wiring diagram for each analog or pulse frequency loop.
 - a. Loop diagrams similar to ISA format or one preferred by DISTRICT.
 - b. Conform to the minimum requirements of ISA S5.4.
 - c. Under paragraph 5.3 of ISA S5.4, include the information listed under subparagraphs 2, 5, 6 and 9.
 - d. Drawing Size: Individual 11-inch by 17-inch sheet for three loops maximum. Loop drawings smaller than 11" x 17" will be rejected without review.
 - e. Divide each loop diagram into areas for field panel, field, terminal junction boxes, control panel and PLC.
 - f. Show:
 - 1) Terminal numbers, location of DC power supply, and location of common dropping resistors.
 - 2) Switching contacts in analog loops and output contacts of analog devices. Reference specific control diagrams where functions of these contacts are shown.
 - 3) Tabular summary on each diagram:
 - a) Transmitting Instruments: Output capability.
 - b) Receiving Instruments: Input impedance.

- 4) Circuit and raceway schedule.
7. Panel Power Requirements and Heat Dissipation: For control panels tabulate and summarize:
 - a. Required voltages, currents, and phases(s).
 - b. Maximum heat dissipations Btu per hour.
 - c. All calculations.
8. Termination Wiring Diagrams:
 - a. Diagrams, device designations, and symbols in accordance with NEMA ICS 250.
 - b. Show:
 - 1) Electrical connections between equipment, consoles, panels, terminal junction boxes, and field mounted components.
 - 2) Component and panel terminal identification numbers, and external wire and cable numbers.
 - 3) Circuit names matching Circuit and Raceway Schedules.
 - 4) Intermediate terminations between field elements and panels for, but not limited to terminal junction boxes and pull boxes.
9. Installation Details: Provide installation details and bill of materials required for the proper installation of AS Components.
10. Spares, expendables, and test equipment.
- B. Samples: Color schedule with color samples for control panels.
- C. Quality Control Submittals:
 1. Testing Related Submittals: In accordance with this Section
 2. O&M Manuals:
 - a. Refer to paragraph Shop Drawings for the following items:
 - 1) Bill of Materials.
 - 2) Catalog Cuts.
 - 3) Component Data Sheets.
 - 4) Interconnection Diagrams, one reproducible copy.
 - 5) Loop Diagrams, one reproducible copy.
 - 6) Termination Wiring Diagrams, one reproducible copy.
 - b. Device O&M manuals for I&CS components, electrical devices, and mechanical devices shall include:

- 1) Operations procedures.
- 2) Installation requirements and procedures.
- 3) Maintenance requirements and procedures.
- 4) Troubleshooting procedures.
- 5) Calibration procedures.
- 6) Internal schematic and wiring diagrams.
- 7) ORT Component and Calibration Sheets.
- 8) List of required test equipment.

c. List of spares and expendables required and recommended.

1.4 DELIVERY, STORAGE, AND HANDLING

A. In accordance with this Section.

1.5 ENVIRONMENTAL REQUIREMENTS

A. Standard Environmental Requirements: Unless otherwise noted, design AS equipment for continuous operation in these environments:

1. Inside (Digester building):

- a. Temperature: 20 to 115 Deg. F.
- b. Relative humidity: 10 to 95% non- condensing.
- c. NEC classification: Non-hazardous.

2. Outside:

- a. Temperature: -32 to 120 Deg. F.
- b. Rain
- c. NEC classification: Non-hazardous except in enclosed wetwell or Digester where it is classified as Class 1 Div I hazardous location specified on the drawings.

B. Furnish and provide I&CS components and panels for continuous operation in its operating environments as shown and located on the Drawings. All equipment shall be suitable and designed for installation as per California Building Code regarding seismic requirements and compliance.

1.6 SEQUENCING AND SCHEDULING

A. In accordance with the DISTRICT general construction schedule.

1.7 MAINTENANCE

A. Spares Parts:

Provide the following spare parts with no additional cost to the DISTRICT. See section 13470 for additional spare parts for PLC system.

Description	Percent of Each Type and Size Used	No Less Than
Fuses	20	5
Indicating light bulbs	20	10
Relays	2	2
Terminal Blocks	10	5
Hand Switches	2	2

B. Expendables: None

1.8 WARRANTY

A. The Contractor shall provide a written warranty covering the performance, workmanship, and installation of all equipment furnished under this Section for a period of two (2) years. The Contractor shall assume responsibility for all costs incurred in achieving satisfactory performance during the warranty period. Warranties shall be in accordance with these specifications.

PART 2 PRODUCTS

2.1 TEST EQUIPMENT AND TOOLS

Contractor shall provide the following tool to the DISTRICT for no additional cost.

Equipment	Quantity	Manufacturer and Model number
None	NA	NA

2.2 I&CS COMPONENTS

A. Components for Each Loop: Components for each loop shall be listed in ISA Data Sheets. Furnish all equipment that is necessary to achieve required loop performance.

2.3 NAMEPLATES AND TAGS

A. Panel Nameplates: Enclosure identification located on the enclosure face.

1. Location and Inscription: As shown on panel Drawing.
2. Materials: 16-gauge, Type 316, stainless steel, stamped, mounted with stainless steel screws.

3. Letters: 1/2-inch, unless otherwise noted.
- B. Component Nameplates-Panel Face: Component identification located on panel face under or near component.
 1. Location and Inscription: As shown on panel Drawing.
 2. Materials: Adhesive backed laminated plastic.
 3. Letters: 3/16-inch white on black background, unless otherwise noted.
- C. Component Nameplates-Back of Panel: Component identification located on or near component inside of enclosure.
 1. Inscription: Component tag number.
 2. Materials: Adhesive back, laminated plastic.
 3. Letters: 3/16-inch white on black background, unless otherwise noted.
- D. Service Legends: Component identification nameplate located on face of component.
 1. Inscription: As shown on panel Drawing.
 2. Materials: Adhesive backed laminated plastic.
 3. Letters: 3/16-inch white on black background, unless otherwise noted.
- E. Nametags: Component identification for field devices.
 1. Inscription: Component tag number.
 2. Materials: 16-gauge, 316 stainless steel.
 3. Letters: 1/4-inch imposed.
 4. Mounting: Affix to component/field instruments with 16- or 18-gauge stainless steel wire or stainless steel screws.

2.4 PANEL FABRICATION

- A. General:
 1. Panels with external dimensions and instruments arrangement as shown on Drawings except as modified in Engineer approved shop drawings.
 2. Panel Construction and Interior Wiring: In accordance with the National Electrical Code (NEC), state and local codes, and applicable sections of NEMA, ANSI, UL, and ICECA.

3. Fabricate panels, install instruments, wire, and plumb, all at the ICS subcontractor's factory.
 4. All panels shall be UL listed and shall bear UL label stating "LISTED ENCLOSED INDUSTRIAL CONTROL PANELS". (UL508)
 5. Electrical Work: In accordance with the applicable requirements of Division 16, ELECTRICAL.
- B. Temperature Control:
1. Smaller Panels (that are not freestanding): Size to adequately dissipate heat from equipment mounted inside panel or in panel face.
- C. Panel Construction:
1. Materials: Sheet steel unless otherwise shown on Drawings with minimum thickness of 10-gauge. For NEMA 4X, 309 stainless steel shall be used.
 2. Panel Fronts:
 - a. Fabricated from a single piece of sheet steel unless otherwise shown on Drawings.
 - b. No seams or bolt heads visible when viewed from front.
 - c. Panel Cutouts: Smoothly finished with rounded edges.
 - d. Stiffeners: Steel angle or plate stiffeners or both on back of panel face to prevent panel deflection under instrument loading or operation.
 3. Internal Framework:
 - a. Provide structural steel for instrument support and panel bracing.
 - b. Permit panel lifting without racking or distortion.
 4. Lifting rings to allow simple, safe rigging and lifting of panel during installation.
 5. Adjacent Panels: Securely bolted together so front faces are parallel.
 6. Doors:
 - a. Full height, fully gasketed access doors where shown on Drawings.
 - b. Key lockable.
 - c. Latches: Three-point, Southco Type 44 or equal.
 - d. Handles: "D" ring, foldable type.
 - e. Hinges: Full length, continuous, piano type, steel hinges with stainless steel pins.
 - f. Rear Access Doors: Extend no further than 24 inches beyond panel when opened to 90-degree position.
 - g. Front and Side Access Doors: As shown on Drawings.
 - h. Provide a latch to hold door at full open position.

D. Non-Freestanding Panel Construction:

1. Based on environmental design requirements required and referenced in Article ENVIRONMENTAL REQUIREMENTS, provide the following:
 - a. For panels located inside:
 - 1) Enclosure Type: NEMA 12.
 - 2) Materials: Steel.
 - b. For all other panels:
 - 1) Enclosure Type: NEMA 4X.
 - 2) Materials: ABX.
2. Doors:
 - a. Oil resistant gasket sealed with continuous hinge.
 - b. Fiberglass lockable quick release latches.
3. Manufacturers:
 - a. Hoffman or equal.

F. Control Panel Electrical and control components:

Control panel shall be NEMA 3RX stainless steel for outdoor installation and shall be NEMA 12 for indoor locations. Panels shall have the following features:

1. Power Distribution, motor starter within panels:
 - a. Feeder Circuits and motor starters:
 - 1) One or more 120V ac, 60-Hz feeder circuits as shown on Drawings.
 - 2) Make provisions for feeder circuit and starter conduit entry.
 - 3) Furnish terminal board for termination of wires.
 - b. Power Panel: Furnish main circuit breaker and a circuit breaker on each individual branch circuit distributed from power panel.
 - 1) Locate to provide clear view of and access to breakers when door is open.
 - 2) Breaker sizes: Coordinate such that fault in branch circuit will blow only branch fuse but not trip the main breaker.
 - 3) Breaker and motor starter manufacturers and products:
 - a) Refer to Division 16, ELECTRICAL.

2. Signal Distribution:
 - a. Within Panels: 4 to 20 mA dc signals (may be distributed as 1 to 5V dc with a precision 250 OHM resistor).
 - b. Outside Panels: Isolated 4 to 20 mA dc only.
 - c. All signal wiring shall be twisted, shielded pairs, minimum 18 AWG.
3. Signal Switching:
 - a. Use dry circuit type relays or switches.
 - b. No interruption of 4 to 20 mA loops during switching.
 - c. Switching Transients in Associated Signal Circuit:
 - 1) 4 to 20 mA dc Signals: 0.2 mA, maximum.
 - 2) 1 to 5V dc Signals: 0.05V, maximum.
4. Relays:
 - a. General:
 - 1) Relay Mounting: Plug-in type socket.
 - 2) Relay Enclosure: Furnish dust cover.
 - 3) Socket Type: Screw terminal interface with wiring.
 - 4) Socket Mounting: Rail.
 - 5) Provide holddown clips.
 - b. Signal Switching Relay:
 - 1) Type: Dry circuit.
 - 2) Contact Arrangement: 4 Form C contacts.
 - 3) Contact Rating: 0 to 5 amps at 28V dc or 120V ac.
 - 4) Contact Material: Gold or silver.
 - 5) Coil Voltage: As noted or shown.
 - 6) Coil Power: 0.9 watts (dc), 1.2VA (ac).
 - 7) Expected Mechanical Life: 10,000,000 operations.
 - 8) Expected Electrical Life at Rated Load: 100,000 operations.
 - 9) Indication Type: LED indicator lamp.
 - 10) Seal Type: Hermetically sealed case.
 - 11) Manufacturer and Product: Potter and Brumfield; Series KH/KHA, Idec equivalent, or equal.
 - c. Control Circuit Switching Relay, Nonlatching:
 - 1) Type: Compact general purpose plug-in.
 - 2) Contact Arrangement: 3 Form C contacts.
 - 3) Contact Rating: 10A at 28V dc or 240V ac.

- 4) Contact Material: Silver cadmium oxide alloy.
- 5) Coil Voltage: As noted or shown.
- 6) Coil Power: 1.8 watts (dc), 2.7VA (ac).
- 7) Expected Mechanical Life: 10,000,000 operations.
- 8) Expected Electrical Life at Rated Load: 100,000 operations.
- 9) Indication Type: Neon or LED indicator lamp.
- 10) Push to test button.
- 11) Manufacturer and Product: Potter and Brumfield; Series KUP, Idec equivalent, or equal.

d. Control Circuit Switching Relay, Latching:

- 1) Type: Dual coil mechanical latching relay.
- 2) Contact Arrangement: 2 Form C contacts.
- 3) Contact Rating: 10A at 28V dc or 120V ac.
- 4) Contact Material: Silver cadmium oxide alloy.
- 5) Coil Voltage: As noted or shown.
- 6) Coil Power: 2.7 watts (dc), 5.3VA (ac).
- 7) Expected Mechanical Life: 500,000 operations.
- 8) Expected Electrical Life at Rated Load: 50,000 operations.
- 9) Manufacturer and Product: Potter and Brumfield; Series KB/KBP, Idec equivalent, or equal.

e. Submersible pumps thermal and leak detection relays:
Refer to Section 11312G- Submersible Pumps for detailed requirements.
Relays shall be manufactured by Flygt Model CAS II, Goulds Pumps equivalent, or equal.

f. Signal conditioners:
Signal conditioners shall be manufactured by AGM Electronics, Phoenix Contact, or equal. They shall have the following characteristics:

- 1) Din rail mounted
- 2) 24VDC power input or two wire as required by design loop drawings.
- 3) 4-20mADC input with two identical 4-20mADC outputs or
- 4) Pulse input with 4-20mADC output or
- 5) 4-20mADC input with isolated 4-20mADC output

g. Intrinsically safe relays:
These relays shall be suitable for use with 120VAC power input with pilot devices such as float switches located in the classified hazardous locations as defined by NEC Article 500. Each relay shall have two double-pole double throw contacts, each rated for 5 amperes at 240V. These relays shall be manufactured by Consolidated Electric, Gem Sensors, R. Stahl, Inc, or equal.

5. Centralized Power Supplies:

- a. Furnish as required where shown on the drawings to power instruments requiring external dc power, including two-wire transmitters and dc relays.
 - b. Convert 120V ac, 60-Hz power to dc power of appropriate voltage(s) with sufficient voltage regulation and ripple control to assure that instruments being supplied can operate within their required tolerances.
 - c. Furnish redundant dc power supplies connected in such a way that DC output power is uninterrupted when one power supply is removed or is not delivering the correct output voltage.
 - d. Provide a contact closure for alarm in case of dc power supply failure.
 - e. Provide a voltmeter for each power supply.
 - f. Provide output over voltage and over current protective devices to:
 - 1) Protect instruments from damage due to power supply failure.
 - 2) Protect power supply from damage due to external failure.
 - g. Enclosures: NEMA 1.
 - h. Mount such that dissipated heat does not adversely affect other components.
Fuses: For each dc supply line to each individual two-wire transmitter.
 - 1) Type: Indicating.
 - 2) Mount so fuses can be easily seen and replaced.
 - i. Manufacturer and Products: Acopian Redundant Power Packages, Sola equivalent, or equal.
6. Standard Pushbutton Colors and Inscriptions:
- a. Use following color code and inscriptions for pushbuttons unless otherwise noted:

Tag Function	Inscription(s)	Color
OO	ON OFF	Red Green
OC	OPEN CLOSE	Red Green
OCA	OPEN CLOSE AUTO	Red Green White
OOA	ON OFF AUTO	Green Red White

Tag Function	Inscription(s)	Color
MA	MANUAL AUTO	Yellow White
SS	START STOP	Red Green
RESET	RESET	Red
EMERGENCY STOP	EMERGENCY STOP	Red
LOCAL	LOCAL	White

b. Unused or Noninscribed Buttons: Black.

c. Lettering Color:

- 1) Black on white and yellow buttons.
- 2) White on black, red and green buttons.

7. Standard Light Colors and Inscriptions:

a. Use following color code and inscriptions for service legends and lens colors for indicating lights, unless otherwise noted in Instrument List:

Tag Function	Inscription(s)	Color
ON	ON	Green
OFF	OFF	Red
OPEN	OPEN	Red
CLOSED	CLOSED	Green
LOW	LOW	Green
FAIL	FAIL	Red
HIGH	HIGH	Red
AUTO	AUTO	White
MANUAL	MANUAL	Yellow
LOCAL	LOCAL	White
REMOTE	REMOTE	Yellow

b. Lettering Color:

- 1) Black on white lenses.
- 2) White on red and green lenses.

2.5 SOURCE QUALITY CONTROL

A. Factory Demonstration Tests: Demonstrate to Engineer that I&CS panel and assemblies included in these tests for conformance to related submittals and requirements specified.

2.6 REQUIRED INSTRUMENTS FURNISHED AND INSTALLED BY CONTRACTOR

2.6.1 PRESSURE INSTRUMENTS

A. Pressure Switches and gauges:

1. General:

- a. Function: Monitor differential pressure, and provide contact closure(s) when differential pressure is at the noted set point.
- b. Type: Diaphragm actuated.

2. Performance:

- a. Set Point: As noted.
 - 1) Adjustable over the full range.
 - 2) Set as noted.
- b. Range: The noted set point shall fall between 30 and 70 percent of the range.
- c. Set Point Repeatability: Plus or minus 1/2 percent of range span.

3. Features:

- a. Diaphragm Materials: Buna-N, unless otherwise noted.
- b. Pressure Connection: Nickel-plated brass, unless otherwise noted.

4. Enclosure: NEMA 4X, unless otherwise noted.

5. Signal Interface:

- a. Contact Type: SPDT, snap action switch, rated for 5 amps at 120V ac.

6. Manufacturers:

- a. Ashcroft, B Series.
- b. United Electric, Series 300
- c. Mercoid, Series DP

B. Pressure Transmitter

1. General: Furnish and install transmitter where shown on the drawings.

- a. Measure pressure by detecting force on an integral capacitance diaphragm capsule.

2. Performance:

- a. Range: 0 to 125 psi, 0 to 10 psi respectively.
- b. Provide zero elevation and adjustment.

- c. Span shall be adjustable over 100 to 1 or greater range.
- d. Adjustable damping shall be provided.
- e. Wetted parts shall be 316SS unless otherwise specified.
- f. Accuracy shall be $\pm 0.25\%$ of span.
- g. Transmitter housing shall be rated explosion proof, NEMA 7.
- h. Integral LCD meter with the transmitter housing.
- i. HART protocol
- j. Two-valve SS manifold

3. Signal Interface:

- a. Transmitter output: 4-20mA current regulated to drive any load between 0-750 ohms at 24V DC.
- b. Transmitter: Two wire type (loop powered)

4. Manufacturers:

- a. Rosemount 2051C
- b. Foxboro, ABB
- c. Equal

2.6.2 FLOW INDICATING TRANSMITTERS

A. Magnetic flow meters

1. General:

- a. Measure flow by flange type low frequency electromagnetic element with DC pulse signal proportional to and linear with liquid flow rate.

2. Performance:

- a. Range: 0 to 3700 gpm
Diameters : 4-inch
- b. Sensor: Minimum two bullet-nosed, self-cleaning electrodes
- c. Meter housing hardware: NEMA 6 Submergence, epoxy painted
- d. Sensor electrode: 316 Stainless Steel, Polyurethane liner, grounding rings
- e. Accuracy: 0.25% of full rate
- f. Electronic transmitter with 4-20maDC output, 3-line, 16-character LCD Display and pulse/frequency for totalization signals. NEMA 4X enclosure, 120VAC input, HART protocol,
- g. Environment: 20 to 140 degrees F, humidity 90% non-condensing
- h. Hand-held calibrator/programmer (shall be provided at no additional cost)

3. Manufacturers:

- a. ABB Magmaster to match District's Standards.

PART 3 EXECUTION

3.1 GENERAL

- A. Floor plan layout for I&CS components are diagrammatic and not intended to specifically define element locations or piping and tubing run lengths. Base materials and installations on field measurements.
- B. Coordinate Work with Division 11, EQUIPMENT and Division 15, MECHANICAL.
- C. Wiring: Refer to this Section and Division 16, ELECTRICAL.

3.2 FIELD QUALITY CONTROL

- A. Perform functional tests to assure all devices are functional individually prior to system testing.
- B. Perform final acceptance testing at the presence of the DISTRICT's representative, the Engineer.

END OF SECTION

SECTION 13130 – FLAT CIRCULAR CLARIFIER COVERS

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall furnish all labor, materials, and equipment required to provide a complete, installed system of fixed and removable, custom fit, extruded aluminum beam supported flat cover with all appurtenances for the South Primary Clarifier as indicated on the contract drawings and as specified herein. The Tank Cover system includes cover panels, structural supports, and attaching hardware. Each cover shall be designed, furnished, delivered, and installed complete with beam supports, panels, all required fasteners, sealant and gaskets, anchor bolts, access hatches, duct and inlet curb, expansion anchors, and all accessories and appurtenances specified herein and indicated on the Contract Documents, or as otherwise required for a complete installation.
- B. Provisions shall be made for the access hatches, scum skimming equipment, weir covers, and other components indicated on the Contract Documents. The covers shall be designed so as not to interfere with the operation of the scum skimming equipment at design loads.
- C. Design of the clarifier covers shall be fully compatible and coordinated with the design of the WesTech Clarifier Mechanism.
 - 1. The two halves of the clarifier cover, together with WesTech clarifier equipment/structure, shall form a substantially air tight cover for the South Primary Clarifier. Interfaces between the cover and clarifier shall be appropriately mated or gasketed to achieve air tightness.
 - 2. The cover structure shall not interfere with any aspect of the clarifier operation.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. ASCE 7 Minimum Design Loads for Buildings and Other Structures
- B. ASCE 7-93 Specification for the Design of Cold-Formed Stainless Steel Structural Members
- C. ASTM C509 Standard Specifications for Cellular Elastomeric Preformed Gasket and Sealing Material
- D. ASTM F593 Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
- E. Aluminum Association Specification for Aluminum Structures
- F. Aluminum Association Aluminum Standards and Data
- G. Federal Specification TT-S-00230, C

1.3 CONTRACTOR SUBMITTALS

- A. General: CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished under this Section and in referenced Sections.
- B. Shop Drawings and Samples: In addition to the requirements of Section 01330 – Submittal Procedures, CONTRACTOR shall submit the following:
 - 1. Complete structural calculations showing the governing stresses in all members and connections, and detailed shop drawings. Calculations verify conformance to deflection limits for structural members as well as walking surface. Preliminary drawings shall be stamped by cover MANUFACTURER's PE. Final Drawings and calculations shall bear the stamp and signature of a California-licensed Professional Engineer as required.
 - 2. A letter of certification signed and sealed by a California-licensed Professional Engineer confirming that the aluminum cover is in full compliance with the plans and specifications including any testing provisions included therein.
 - 3. Records certifying the satisfactory inspection of all structural welds of aluminum components shall be submitted prior to delivery of the fabricated materials.
- C. O & M Manuals: The CONTRACTOR shall provide operators and maintenance data for all equipment furnished for the project in accordance with Section 01730 - Operation and Maintenance Data.
- D. Tools: Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the WORK hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

1.4 QUALITY ASSURANCE

- A. CONTRACTOR shall submit the following:
 - 1. MANUFACTURER's Certificate of Proper Installation
 - 2. Functional Test Certification
 - 3. Factory performance test reports
 - 4. Special shipping, storage and protection, and handling instructions
 - 5. MANUFACTURER's printed installation instructions
 - 6. List of suggested spare parts to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance.
 - 7. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.

B. Warranty

1. A written suppliers warranty shall be provided for the equipment specified in this section as required in Section 01740 - Warranty.

1.5 MANUFACTURERS SERVICE REPRESENTATIVE

- A. Manufacturer's Representative. In accordance with the requirements of Section 01730 - Operation and Maintenance Data, a Manufacturer's Representative shall be present at the site or classroom designated by the OWNER to provide the services and minimum person-days listed below, travel time excluded.

1. 2 person-days for installation assistance and inspection,
2. 2 person-days for functional and performance testing
3. 2 person-days for pre-startup training of OWNER's personnel.

PART 2 PRODUCTS

2.1 GENERAL

- A. The cover shall consist of a near flat deck comprised of panels and supported by beams located above the cover. The cover shall be clear-span and self-supporting from the peripheral structure.
- B. Complete design and construction of the beam cover and all appurtenances as specified herein shall be performed by one single MANUFACTURER.
- C. All welding of aluminum shall be performed in the shop in accordance with the recommendations of the American Welding Society and the Aluminum Association, Section 7. Welding shall be with electrodes of an alloy, which shall produce welds with strength and corrosion resistant characteristics compatible to the base metal. Welds shall be free of porosity, cracks, holes, and entrapped slag. Field welding of aluminum will not be acceptable.

2.2 FLAT CIRCULAR CLARIFIER COVER

A. General

1. The cover will be installed on a Primary Clarifier which receives screened and degrittied wastewater from the headworks. Odor control fans will be used to maintain a partial vacuum beneath the cover to collect and convey foul air to the bio scrubbers for treatment. The cover and all materials used therein shall be resistant to corrosion and shall be certified by the cover MANUFACTURER as fully suitable for continuous exposure to water saturated air containing hydrogen sulfide, mercaptans, and ammonia at temperatures ranging from 20 degrees F to 100 degrees F.
2. The covers shall be fabricated, assembled, delivered, erected, and placed in proper operating condition in full conformity with drawings, specifications, engineering data, instructions, and recommendations furnished by the MANUFACTURER unless exceptions are noted by the ENGINEER.

3. The clarifier cover shall be two parts, split around the clarifier mechanism.
4. The flat panel cover shall conform to the specified dimensions, as verified by the Contractor in the field, and shall consist of flat aluminum interlocking panels supported by a series of adjoining beams. All panels shall interlock with the adjoining beam/beams without the use of threaded fasteners. Uplift of each panel will be resisted with the use of an integral latch system.
5. The beam cover shall be designed to accommodate all ductwork, access hatches, clarifier drive mechanism, and all other pertinent items as required.
6. The system shall be self-supported from the basin walls as indicated on the drawings. Ponding of water on top of the cover will not be acceptable.
7. An elastomeric weather seal gasket shall form a continuous seal along all panel edges. The seal shall be substantially watertight. The gaskets shall be fully enclosed to prevent ultraviolet exposure. Gaskets shall be provided at the mating surface between the cover and mechanism.
8. The top surface of the panels shall be flush and free of tripping hazards such as bolt heads or fasteners of any type.
9. The cover shall possess an integral non-skid surface and no exposed area of cover system wider than one inch shall be without ribs/non-skid surface. The aluminum-decking surface of the structure shall be Hallsten's Deck Slat, which is ribbed to provide an aggressively non-skid surface. The edges of adjacent deck slats shall double interlock so that the slats shall act together. The decking surface shall be manufactured from 6061-T6 alloy. The Manufacturer of the non-skid surface shall demonstrate in writing satisfactory performance for a minimum period of 10 years in the wastewater industry for the intended purpose. The use of checkered plate, paint, tape, sand blasting or other applied systems to achieve the slip resistant surface is expressly prohibited.
10. Dissimilar materials which are not compatible with the aluminum cover shall be physically separated or insulated by means of elastomeric gaskets.
11. Access hatches:
 - a. Shall be provided as indicated on the drawings and shall be subject of the structural design criteria specified herein. Access to any location under the cover shall be gained through access hatches and frames or integral gear hinged access hatch panels.
 - b. The access hatch panels shall have the identical properties as the rest of the aluminum cover including loads, deflection, and slip resistance specifications. The access-hinged panels shall be the full panel width. The length of the access panel shall be clearly indicated on the shop drawings. Hinged panel components including hinges, decking, and lifting handles shall be extruded 6061-T6. Handles shall be an integral flush mounted aluminum and incorporated into the non-skid deck slat. While in the closed position the hatches will be completely flush therefore posing no tripping hazard and shall be sealed with a gasket or by other acceptable means. In the open position the panel shall lie flat on the cover and will not need a hold open device. Two recessed handles or

equivalent lifting means shall be provided at each end of each removable panel.

- c. Temporary guardrail and sockets designed according to OSHA standards shall be provided at the perimeter of the supports for hatch panels. When panels are removed, there shall be a clear span between the beam supports as shown on the drawings. No beams or box beams shall remain in the basins.
12. Hinged weir covers: Shall be provided as shown on the drawings and around the circumference of the clarifiers on alternating panels. The weir covers shall be easily accessible and shall allow full access to the weirs for cleaning and maintenance. The weir covers shall be skid resistant as specified above.

B. Design Loading Requirements

1. The beam supported flat cover shall be designed in accordance with "Aluminum Design Manual" as published by the Aluminum Association and designed for full dead load plus live load in accordance with applicable local codes.

2. The load cases to be considered shall be those described below:

Uniform Live Load	50 psf
Unbalanced Live Load	100 percent of the Uniform Live Load acting over one half of the cover with no live load on the other half
Wind Load	As specified on Drawing GS-1 - Wind Design Criteria
Vacuum/Pressure Load	1 inch water column
Seismic Zone	As specified on Drawing S-1 - Seismic Design Criteria

3. Load Combinations: The loads described above shall be applied to the cover in the following combinations
 - a. Dead Load
 - b. Dead Load, Uniform Live Load, and Vacuum Load
 - c. Dead Load, Unbalanced Live Load, and Vacuum Load
 - d. Dead Load, Wind Load, and Pressure Load
 - e. Dead Load, Uniform Live Load, and Wind Load
 - f. Dead Load, Unbalanced Live Load, and Wind Load
4. Temperature: The load combinations listed above shall be considered for a temperature change of 100 degrees F below the installation temperature and 100 degrees F above the installation temperature, and for a material temperature range of 40 degrees F below to 60 degrees F above zero.
5. Panel Design Load: In addition to the above mentioned loads and load combinations, the structural components shall be designed to support a 400-

pound load on a 6" X 6" area located anywhere on the surface of the structure without permanently deforming the tested area. This load is to be taken as acting separately and not simultaneously with other design loads.

6. For the above loads and load combinations, the deflection of all components (structural and cladding) shall not exceed $L/240$ with L equal to the short span of the component. This deflection limit applies not only to the flat cover as a whole, but also to the skin of the cover spanning between the supporting edges of each panel or module. In no event shall the dead load deflection exceed the rise of any component in order to avoid surface ponding. Calculations by a registered Professional Engineer shall be provided at the time of submittal to ensure that this requirement has been met.
7. Beams shall be designed to resist all loads imposed during erection without exceeding allowable stresses or causing permanent deformation.
8. Primary horizontal thrust shall be carried by members so that no horizontal loads due to the coefficient of friction (not to exceed 10 percent of the maximum load) are transferred to the walls. All connections shall be designed to permit expansion and contraction of the cover.
9. The dead weight of the flat covers shall not exceed 150 pounds per panel; each removable panel shall be easy to remove without disruption of adjacent panels and panels shall be easily removable with a lifting force not exceeding the dead weight of the panel, provided that the odor control fans are turned off. The dead weight of access hatches shall not exceed 100 pounds.

C. Appurtenances

1. Cover to clarifier mechanism Interface: The cover interface with the clarifier drive mechanism and center platform shall be designed to minimize air leakage and facilitate maintenance of the drive mechanism. The cover MANUFACTURER shall coordinate with the clarifier mechanism MANUFACTURER for interface of the cover and the clarifier drive mechanism.
2. Odor Control Duct Nozzle: Provide as indicated on the Drawings. The MANUFACTURER shall provide ANSI 16.1, Class 25 flanges at the indicated locations. All joints between the aluminum connection flange and the panel shall be suitably reinforced, gasketed, and permanently sealed weather tight.
3. Make-up Air Vents: Provide aluminum make-up air vents as indicated on the Drawings. The MANUFACTURER shall provide ANSI 16.1, Class 25 flanges. All joints between the air inlet ducts and the panel shall be suitably reinforced, gasketed, and permanently sealed weather tight.

D. Fabrication and Workmanship

1. Workmanship: The quality of workmanship shall be equal to the best general practice in modern structural fabrication shops. Workmanship, fabrication, and shop connections shall be in accordance with the latest edition of ANSI/AWS D1.2 "Structural Welding Code - Aluminum".

2. Experience: The MANUFACTURER must furnish adequate evidence of a minimum of ten (10) years of ongoing experience in the manufacture of similar structures.
3. Preparation for Welding: All components to be welded shall be free of dirt, grease, and other contaminants and shall fit up properly for sound welding. Surfaces to be welded may not be cut with oxygen. Sawing, shearing, or machining may be used.
4. Welding Procedures: All welding shall be with an inert gas shield arc process. Machine settings shall be developed with test welds of the same material, alloy and geometry as the work pieces and samples will be tested destructively.

2.3 MATERIALS OF CONSTRUCTION

- A. All metallic material used in the construction of the covers shall be aluminum or stainless steel that is suitable for the corrosive conditions. Materials of construction shall be as follows:

Structural Shapes or Aluminum Extrusion, 6061-T6
Support Members

Panels 6061-T6, not less than 0.1 inch thick

Bolts and Fasteners 6061-T6 aluminum or 316 stainless steel. The use of plastic fasteners is prohibited

Sealant Shall be resistant to ozone and ultraviolet light, and conform with Federal Specification TT-S-00230C

Gaskets All gaskets shall be Santoprene conforming with ASTM C-864 or ASTM C509, resistant to ozone, and shielded from exposure to ultraviolet light. No foam tape or caulk shall be allowed.

Access Hatches 6061-T6 aluminum, not less than 0.09 inch thick

Duct and Air Inlet Curb 6061-T6 aluminum, not less than 0.125 inch thick

- B. All exposed surfaces of the cover shall be sandblasted in accordance with commercial sand blast SSPC-SP-6-63 which produces an AA-M44 (coarse matte) finish. Sandblasting of cover system is to reduce glare from cover surface only and shall not be an acceptable means to achieve skid resistance.
- C. All fasteners between aluminum components shall be stainless steel. Aluminum shall be isolated from dissimilar materials by means of a stainless steel spacer or an elastomeric isolator. Beams and panels shall be fastened to concrete using stainless steel drill in place anchor bolts.
- D. No carbon steel components shall be used.

- E. A mechanical and replaceable Santoprene seal shall isolate the cover perimeter from dissimilar materials such as concrete and steel. No foam tape or caulk shall be allowed for isolation of cover system.

2.4 SPARE PARTS

- A. The Contractor shall obtain from the manufacturer a list of suggested spare parts of all items of each piece of equipment subject to wear, such as seals, packing, gaskets, nuts, bolts, washers, wear rings, bearings, etc. Furnish spare parts suitably packaged and labeled in a box in the same manner as required for tools.

2.5 MANUFACTURERS

- A. MANUFACTURER's Responsibility: The MANUFACTURER of the aluminum flat beam supported cover shall provide and erect the cover in the field and shall certify that the cover and all appurtenances have been properly erected in conformance with the Contract Documents and the MANUFACTURER's requirements.
- B. Unit Responsibility: The cover manufacturer shall be responsible for all equipment provided under this section.
- C. Manufacturer, No Equals (to match existing):
 - 1. Hallsten

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. A complete set of MANUFACTURER's drawings, maintenance instructions, and removal and replacement instructions for the installed cover shall be furnished to the OWNER no later than the date the equipment is shipped.
- B. Delivery of the components of the structure shall be made to a location nearest the site that is accessible to over the road trucks, unless otherwise specified.
- C. The components shall be stored off the ground on level surface in such a manner as to prevent damage.

3.2 INSTALLATION

- A. The MANUFACTURER of the aluminum flat beam supported covers shall erect the covers in the field and shall certify that the covers and all appurtenances have been properly erected in conformance with the MANUFACTURER's requirements. Each cover shall be assembled and installed by a trained field crew employed by the cover MANUFACTURER. Mechanics shall be skilled and experienced in fabrication and erection of aluminum structures with a minimum of 5 installations under satisfactory operation for a minimum of 3 years.
- B. MANUFACTURER shall furnish such personnel, tools, equipment, and materials as required to install the cover using the recommended procedure.

- C. All cover components shall be fabricated at the MANUFACTURER's factory. Field refabrication of structural components or panels will not be accepted. Forcing of the structure to achieve "fit-up" will not be accepted.
- D. Field welding of aluminum shall not be allowed.
- E. After installation and field load testing, and completion of all connections, the exterior surfaces of each cover shall be thoroughly cleaned to the satisfaction of the CONSTRUCTION MANAGER in accordance with the MANUFACTURER's recommendations.

3.3 TESTING

- A. Factory Testing: MANUFACTURER shall perform a shop air tightness test and certification for the cover configuration proposed. The air tightness test shall be performed in accordance with the "Procedural Standards for Testing, Adjusting and Balancing of Environment System" as published by the National Environmental Balancing Bureau (NEBB). The test shall be conducted and witnessed by a NEBB certified technician. The method of testing, test apparatus and proposed contents of the test report shall be submitted to the ENGINEER for approval. Subsequent to the receipt of ENGINEER'S approval, the MANUFACTURER shall set up testing protocol and schedule the test. The MANUFACTURER will provide the CONSTRUCTION MANAGER with at least 72 hour notice prior to the scheduled test. A report of the test shall be prepared by a certified technician and shall be sealed with the NEBB seal. The report shall include a description and illustration of the cover configuration, a description and illustration of the test apparatus and a report of the results. The cover shall maintain an air intrusion leakage rate not to exceed 0.2 cfm per square foot at an applied negative pressure of 0.2 inches of water column for a 5-minute duration.
- B. Functional Testing: All tests shall be conducted in a manner acceptable to the ENGINEER and shall be repeated as many times as necessary to demonstrate compliance with specified requirements. Following completion of cover installation, at least two panels of each cover as selected by the ENGINEER shall be field load tested. One panel shall be subjected to a concentrated load consisting of cloth sacks of suitable size, containing earth or sand, applied on a 1 square foot area of the test panel in a location where it will produce maximum flexure and deflection. The concentrated load shall be not less than 1.5 times the concentrated panel design load specified. The second test panel shall be subjected to a uniform test load of 1.5 times the specified uniform design load applied over the entire surface of the panel. The test panels shall withstand the specified field test loads without damage, slippage, or permanent distortion. If either test panel fails to meet the specified requirements, all panels shall be removed, replaced with new panels, and selected panels shall be retested. Panel removal, replacement, and retesting shall be performed at no additional cost to the OWNER.

END OF SECTION

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SECTION 13470
SCADA - PROGRAMMABLE LOGIC CONTROLLER SYSTEM

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. General:

- a. The Contractor shall furnish, install and wire all SCADA PLC system hardware required for this project. The SCADA PLCA system control panel was manufactured by Calcon Systems Inc. All SCADA PLC work in this project shall be done by Calcon match existing system installation. The Contractor shall hire Calcon as the SCADA PLC system integrator to perform the required work which shall include hardware and software programming and configuration. The Contractor shall be required to provide all labor and materials to wire and connect all new signals to the existing PLC systems in coordination and supervision from Calcon as specified and as shown on the drawings.
- b. The existing PLC cabinet shall remain functional during construction, and shall be not be disrupted.

2. Control System Responsibilities:

- a. The Contractor shall be responsible for all control systems work described in these specifications and drawings, including PLCs, network/communication equipment, including programming and configuration services explicitly specified to be performed by Calcon. The Contractor shall be responsible for all submittals, purchasing, assembly, packing, shipping, installation, set up, startup, specified testing, and as-built drawings for all control system equipment and SCADA PLC software.
- b. The Contractor or subcontractor shall test the PLC/I/O system as specified herein to verify proper performance independent of the use of the PLC software provided by Calcon.
- c. The Contractor shall provide the communications network as specified herein and indicated on the Drawings and other sections of the specification.
- d. Perform testing and training as described in this section.

3. Definitions:

- a. Where a term is used in this section relating to instrumentation, and the meaning is not defined therein or elsewhere in the Contract Documents, the meaning of the term shall be as defined in ISA S51.1 Process Instrumentation Terminology, or if not contained in ISA 51.1, as defined in listed reference standards under "References".
- b. CEET - Complete End to End Testing.
- c. Control Circuit: Any logical circuit (operating usually at 120VAC or less or DC) whose principal purpose is the conveyance of control and interlock/protection information and not the conveyance of energy for the operation of an electrically powered device.

- d. HMI: Human Machine Interface.
- e. LAN: Local Area Network e.g. Ethernet is a local area network based on IEEE standard 802.3 with TCP/IP protocol.
- f. NAT - Network Acceptance Testing.
- g. Panel: An instrument support system which may be either a flat surface, a partial enclosure, or a complete enclosure for instruments and other devices used in process control systems. Unless otherwise specified or clearly indicated by the context, the term “panel” in these Contract Documents shall be interpreted as a general term, which includes flat panels, enclosures, cabinets and consoles.
- h. PLC: Programmable Logic Controller.
- i. Power Circuit: Any circuit operating at 120 VAC or more, whose principal purpose is the conveyance of power for motors, lighting and other power devices.

B. Test:

1. General:

- a. Any testing or startup activity that requires the participation of the District shall be scheduled by the Contractor through written notification to the District. Contractor shall provide regularly updated testing and startup schedules to the District. In addition to any other form of notification, Contractor shall notify the District by email, or other mutually agreed upon means, five working days immediately prior to any testing or other activity requiring the participation of the District. Failure to properly notify District shall result in rescheduling of test activity, solely at Contractor expense and without an extension to the project completion schedule.

2. Operational Readiness Tests (ORT):

- a. General: Prior to startup and the Functional Acceptance Test, the entire system shall be certified (inspected, tested and documented) that it is ready for operation.
- b. Basic End-to-End Testing (BEET):
 - i. For each and every analog and discrete circuit, perform Basic End-to-End Testing (BEET). This includes, but is not limited to, all local control panels, MCCs, VFDs, and hardwired circuits in control panels.
 - ii. For each input, activate the signal at the primary field device, either by creating necessary process and equipment conditions or by disconnecting the wires at the field device and simulating the input signal. At the PLC, using the PLC programming software, verify proper receipt of the signal.
 - iii. For each output signal from the PLC, activate the PLC output signal using the PLC programming software, and verify proper receipt of the signal at the controlled device in the field, either by observing equipment operation or by disconnecting the wires at the equipment and verifying proper receipt of the signal.
 - iv. Verify proper signal receipt at all intermediate devices, such as indicators, signal trip and relay modules, etc.

- v. The Loop/Component Inspections and Tests shall be implemented using District-approved forms and checklists.
- vi. Each loop shall have a Loop Status Report to organize and track its inspection, adjustment and calibration. These reports shall include the following information and check off items with spaces for sign off by the system supplier:
 - a). Project Name.
 - b). Loop Number.
 - c). Tag Number for each component.
 - d). Check offs/signoffs for each component.
 - e). Tag/identification.
 - f). Installation.
 - g). Termination - wiring.
 - h). Termination - tubing.
 - i). Calibration/adjustment.
 - j). Signoffs/signoffs for the loop.
 - k). Panel interface terminations.
 - l). I/O interface terminations.
 - m). I/O signal operation.
 - n). Inputs/outputs operational: received/sent, processed, adjusted.
 - o). Total loop operation.
 - p). Space for comments.
 - q). Each active Analog Subsystem element and each I/O module shall have a Component Calibration Sheet. These sheets shall have the following information, spaces for data entry and a space for sign off by the system supplier:
 - 1). Project Name.
 - 2). Loop Number.
 - 3). Component Tag Number of I/O Module Number.
 - 4). Component Code Number Analog System.
 - 5). Manufacturer (for Analog system element).
 - 6). Model Number/Serial Number (for Analog system).
 - 7). Summary of Functional Requirements. For example:
 - (a). For Indicators and Recorders: Scale and chart ranges
 - (b). For Transmitters/Converters: Scale and chart ranges
 - (c). For Computing Elements: Function
 - (d). For Controllers: Action (direct/reverse) control modes (PID)

- (e). For Switching Elements: Unit range, differential (FIXED/ADJUSTABLE), reset (AUTO/MANUAL)
 - (f). For I/O Modules: Input or output
- r). Calibrations; for example:
 - 1). For Analog Devices: Required and actual inputs and outputs at 0, 25, 50, 75 and 100 percent of span, rising and falling.
 - 2). For Discrete Devices: Required and actual trip points and reset points.
 - 3). For Controllers: Mode settings (PID).
 - 4). For I/O Modules: Required and actual inputs or outputs for 0, 10, 25, 50, 75 and 100 percent of span, rising and falling; 9 points calibration (5 points calibration will be rejected).
 - 5). Space for comments.
 - 6). Space for sign off by the ISS.
 - 7). The ISS shall maintain the Loop Status Reports and Components Calibration sheets at the job site and make them available to the Construction Administrator/District at any time.
- s). These inspections and tests do not require witnessing. However, the Construction Administrator will review and initial all Loop Status Sheets and Component Calibration Sheets and spot-check their entries periodically and upon completion of the Operational Readiness Tests. Any deficiencies found shall be corrected.
- c. Complete End-to-End Acceptance Tests (CEET):
 - i. For each PLC, CEET testing shall not commence until all Loop Acceptance Tests for the PLC have been satisfactorily completed, and all test results (including all forms signed off) have been submitted for review and accepted. For each and every analog and discrete circuit, perform an end-to-end test between the field device and the HMI computer operator station, and including all intermediate readouts. Also test each signal circuit transmitted over digital networks (i.e. ETHERNET, RS-422 links, etc.).
 - ii. In general, the end-to-end testing is a two or more person test. The Contractor shall provide personnel to operate equipment or simulate signals that are to be verified as part of this test.
 - iii. Check each loop from the field element to the respective computer control display. Include all intermediate field instruments, control devices, panels, indicators and other devices in the loop to ensure proper operation and linkage to computer control station displays.
 - iv. Analog signals shall be tested at 0, 50, and 100 percent of scale to verify the proper receipt on computer control displays.
 - v. Discrete input circuits shall be tested to verify proper state when the field device is switched between states. Discrete output circuits shall be tested to verify equipment responds properly (start, stop, etc.).
 - vi. Contractor shall provide adequate time in the Construction Schedule for CEET testing.

3. FUNCTIONAL ACCEPTANCE TEST (FAT)

- a. Prior to startup and the Functional Acceptance Test (FAT), the entire installed instrument and control system shall be certified that it is ready for operation. All preliminary testing, inspection, and calibration shall be complete as defined in the Operational Readiness Tests.
- b. Once the facility has been started up and is operating, a witnessed FAT shall be performed on the complete system to demonstrate that it is operating and in compliance with these Specifications. Each specified function shall be demonstrated on a paragraph-by-paragraph, loop-by-loop, and site-by-site basis.
- c. Strategy Field Testing (SFT):
 - i. This test shall be performed by the Integrator with the assistance and cooperation of the Contractor. The Contractor shall provide a qualified start-up and testing representative on-site, assisting and participating in the testing full-time, for the duration of the SFT.
 - ii. The Contractor shall include in the Construction Schedule at least two days of SFT testing work for each of the control strategies and shall provide staff for these periods, as required above for this work.
 - iii. For each control strategy and for each electrical schematic diagram, demonstrate the proper operation of all hardware and software logic and control functions. Perform a step by step test of each function described in each control strategy.
 - iv. Perform separate tests on each individual piece of equipment, and for each control loop.
 - v. Perform the proper operation of each discrete control loop to ensure the proper operation of motors, hand switches, interlocks, solenoid valves, other auxiliary devices, status lights, computer control operator interfaces, and alarms.
 - vi. Updated versions of the documentation specified to be provided for during the Factory Tests shall be made available at the job site both before and during the tests. In addition, one copy of all O&M Manuals shall be made available at the job site both before and during testing.
 - vii. The system shall operate for a continuous 96 hours without failure before this test will be considered successful.

1.2 QUALITY ASSURANCE

A. References:

1. Work specified in this Section shall follow the applicable code and standards: EIA, ANSI, IEEE, ISA and NFPA.
2. Where provisions of the pertinent codes and regulations, requirements of the referenced standards, or these specifications conflict, the more stringent of the requirements shall govern.

1.3 SUBMITTALS

A. General:

1. Make all submittals and resubmittals in strict accordance with the provisions of Division 1, Section 1A-7 - Submittals, Manuals, Operating Instructions, and Affidavits.
2. Make all submittals listed in Part 1.03-B, and any others required to fully describe what is to be furnished and/or installed under this Section.

B. Required Submittals:

1. Drawing index and detail part list.
2. System configuration diagram.
3. Hardware list and cutsheets.
4. Bill of materials.
5. Test plan.

PART 2 – PRODUCTS

2.1 MANUFACTURER AND SUPPLIER

- A. The PLC components shall be manufactured by Automation Direct DL4 Series to match the District SCADA Standards. No other manufacturers are acceptable. The PLC-6 and its auxiliaries shall be integrated in an existing enclosure located in existing Digester building. This modifications and additions shall be done and coordinated by Calcon. Contractor shall provide complete wiring from the field to the I/O cards' terminals as detailed on the drawings. The PLC-6 and its auxiliaries shall be as shown on the Drawings and as specified in this section:
- B. Provide and install the following hardware to the PLC-6 as shown on the drawings and as described in this section:
 1. One 16-point Digital Input cards model no. D2-16ND3-2
 2. Miscellaneous accessories such as interposing 24VDC relays, fuses, terminal strips, contact blocks etc
- C. Loose spare parts for no additional costs:
 1. Two 16-point Digital Input cards model no. D2-16ND3-2

PART 3 – EXECUTION

3.1 ACCEPTANCE TESTING

- A. Perform final acceptance testing with the presence of the District and the District's representative. Demonstrate all correct signal wirings and control logics to the District's satisfaction. (The District will furnish PLC/HMI software). Retest shall be performed at no cost to the District if the first test is not satisfactory.

3.2 TRAINING

- A. Provide one 4-hour training sessions for 3 plant personnel at the site. The training shall include classroom and hands-on practice of the system furnished.
- B. Perform factory tests if required in the District's presence. Notify the District one week prior to actual scheduled factory test. See Part 1 for additional requirements.

3.3 PLC/HMI SOFTWARE TESTING ASSISTANCE

- A. The PLC/HMI application software is provided by Calcon hired by the Contractor. The Contractor shall provide assistance to Calcon when they perform software testing in the field during final pump station startup operations. Provide field staff for at least two weeks to assist this effort. See Part 1 for additional requirements. PLC/HMI application software includes configurations of graphic displays to include Clarifier 1 and its functions which include alarms, operational status. Displays for new equipment shall also be configured and included.

3.4 CONTROL STRATEGIES

SEE SECTION 13475 FOR REFERENCES

END OF SECTION

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SECTION 13475

CONTROL STRATEGIES

PART 1 GENERAL

1.01 DESCRIPTION

A. Work Scope:

1. This Section specifies requirements regarding software configuration for existing programmable logic controllers (PLCs), Local HMI display and SCADA System. All software programming and configuration in this project shall be performed by third party (Calcon) hired by the District.

1.02 RELATED SECTIONS

- A. Section 13400 - Instrument and Control System.
- B. Section 13470 - Programmable Logic Controller System.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

- A. The facilities included in the project are designed with a programmable logic controller (PLC) based control system which provides the control and monitoring functions of the pumping equipment and associated auxiliary equipment. In general, the PLC will contain control logic to execute the required control functions based on process parameters such as level in the wet well. Exact system process parameter set points shall be as determined and directed by the Owner during final start up. In addition, the control system shall be programmed to provide all alarm and monitoring functions such as equipment run, fail, overload, open, close, process parameter values (e.g. low-low and high-high set points), and software generated failure-to-start, failure-to-open, and failure-to-close. Each alarm and monitoring function of each piece of equipment shall be duplicated at the HMI and in the SCADA communication network.
- B. In addition to the functions described in the loop specifications, at each programmed layer provide the following general functions as they apply to the signals available to that layer:
1. Monitor and Display Discrete Inputs. Receive inputs, display, and alarm where applicable. Provide alarm logging.
 2. Display and Allow Tuning of Set Points. Display set points, allow them to be changed and where password protection functions are available, and implement them to restrict access to set points.
 3. Monitor and Display Analog and Pulse-Frequency Inputs. Receive inputs and display values. Provide configurable low and high alarm set points for each

signal. Trend each input for a configuration interval in a first-in/first-out arrangement. Provide resettable and non-resettable flow, run-time, and power consumption totalizers for each applicable input.

4. Elapsed Time. Provide resettable and non-resettable elapsed time integrators for pump run-time. For the resettable variable, provide a configurable set point unique to each pump at which an alarm will occur, triggering the need for service.
5. Loss of Input. Hold the last known value or alarm.
6. Attempt to Command Only Controllable Equipment. Monitor equipment status where available (such as LOCAL/REMOTE selection), and attempt to control equipment which is available to the PLC and which has not failed.
7. Pump Fail-to-Start/Fail-to-Stop. Upon issuance of a START or STOP command, if within a configuration interval the pump does not reach the command position, an alarm shall be issued. Provide a configurable interval on a pump-by-pump basis. Lock out the gate until a RESET command is issued.
8. Equipment Fail. On receipt of a FAIL or similar discrete input, or when the item of equipment fails to attain the commanded state within a configurable interval, an alarm shall be issued. Provide a configurable interval for each item of equipment. Lock-out the item of equipment until a RESET command is issued.
9. Loss of Communication. Alarm on loss of communications from the SCADA host to site PLCs and/or from the site PLCs to the SCADA host.

3.02 CONTROL STRATEGIES

3.03 CLARIFIER 1

- A. References:
Drawings: E-4
PLC: PLC-6 located in Digester building

- B. Summary Description:

The clarifier 1 (PC1) includes sludge/scum collection (see also Primary Sludge/Scum Pumping Controls). The sludge collectors operate continuously, under local control only. Operations staff will select ON whenever the clarifiers are receiving primary influent. A manufacturer supplied Local Control Station provides local control of the drive and the scum trough washwater solenoid. Torque and sheer pin status for the clarifier drive is monitored. There is also a position switch to detect skimmer arm rotation. The skimmer arm position switch is used to open the scum trough washwater solenoid valve for a timed duration each time the skimming arm trips the arm position switch.

- C. Field Controls and Instrumentations:

1. Instrumentation
 - a. Skimmer Scum Box Switch: PC1-DRV1-ZSH-01
 - b. Skimmer Scum Box Spray Solenoid Valve: PC1-SVLV01-01
 - c. Scum Pit Spray Solenoid Valve: PC1-SVLV01-02
 - d. Clarifier Drive Torque Limit Switch – High: PC1-DRV1-NSH-01
 - e. Clarifier Drive Torque Limit Switch – High-High: PC1-DRV1-NSHH-01
 - f. Clarifier Drive Shear Pin Switch: PC1-DRV1-ZSH-01
2. Local Control Devices on LCP
 - a. Skimmer Scum Box Spray Solenoid – ON/OFF/AUTO
 - b. Clarifier Drive – ON/OFF/AUTO
 - c. Clarifier Drive – RUN
 - d. Alarm Reset
3. Hardwired Interlocks
 - a. None
4. Local Process Indicators and Alarms
 - a. Clarifier Drive Torque Limit Switch – High torque
 - b. Clarifier Drive Torque Limit Switch – High High torque
 - c. Clarifier Drive Shear Pin Switch – Shut down alarm
 - d. Clarifier Drive RUN, FAIL
 - e. Run Time Indicator
 - f. Control Power Light
5. MCC Status/Control Functions:
 - a. None

- D. PLC/SCADA Monitoring and Control Functions
 - a. Torque Warning – High and High High Torque Alarm
 - b. Scum Pit Spray On/Off/Auto – Auto mode Indicator
 - c. Clarifier Drive RUN
 - d. Clarifier Drive FAIL/OVERLOAD
- 1. Control
 - A. **Automatic Mode**
 - 1. Scum Box Spray

Each time the scum scraper switch is activated the scum box the scum box solenoid shall open for a timed duration (initially set at 60 seconds) each time the skimmer arm trips the arm position switch.
 - B. **Manual Mode:**
 - 1. Clarifier Drive and Sprays

Clarifier Drive and Sprays will operate according to the ON/OFF selector.
- 2. The SCADA screen(s) shall display the following variables and status for each piece of equipment:
 - 1. Torque Warning – High or High High
 - 2. Primary Clarifier Trouble
 - 3. Scum Pit Spray On/Off/Remote – Remote Indicator
 - 4. Clarifier Drive ON
 - 5. Motor Overload
- 3. Software Interlocks: None.
- 4. Trend Variables:
 - a. Clarifier 1 RUN time
- 5. Operator Functions from SCADA Screens when selector switch in PLC Mode:
 - a. Manual Start/Stop: Yes (Clarifier Drive)
 - b. Manual Start/Stop: Yes (Scum Pit Solenoid Valve)

3.04 EQUALIZATION GATES EQ-GAT1 and EQ-GAT2

These existing gates are provided with a new motorized actuator. EQ-GAT1 and EQ-GAT2, in Remote mode, can be manually OPENED or CLOSED by the SCADA system. No AUTO control logic is required. The following status is monitored and displayed in the SCADA system for each gate:

- a. In REMOTE mode
- b. OPENED
- c. CLOSED
- d. FAILED

3.05 Primary Clarifier Sludge Transfer Pump (North and South) and Primary Digester Transfer Pump

These three existing pumps have not been programmed to run in REMOTE mode and shall be modified by Calcon to include automatic functions which shall be specifically instructed by the District during construction phase of the project. The Contractor shall include at least 4 hours of Calcon's programmer to attend meetings with the District and the Engineers for the required functions desired by the District.

END OF SECTION

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SECTION 15000 – PIPING, GENERAL

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall provide all piping systems indicated, complete and operable, in accordance with the Contract Documents. The provisions of this Section shall apply to all piping sections in Divisions 2 and 15.
- B. The Contract Drawings define the general layout, configuration, routing, method of support, pipe size, and pipe type. The Contract Drawings are not pipe construction or fabrication drawings. It is the Contractor's responsibility to develop the details necessary to construct all mechanical piping systems, to accommodate the specific equipment provided, and to provide and install all spools, spacers, adapters, and connectors for a complete and functional system. Flanges and joints in addition to those shown may be necessary to facilitate fabrication and installation.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Without limiting the generality of other requirements of these Specifications, all work specified herein shall conform to or exceed the requirements of the Building Code and the applicable requirements of the following documents to the extent that the provisions of such documents are not in conflict with the requirements of this Section; provided, that for Building Codes, the latest edition of the code, as adopted as of the date of award by the Owner having jurisdiction, shall apply to the Work.
- B. This Section contains references to the following documents. In case of a conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail. The latest edition of the following references at the time of bid shall be used:

ANSI/AWS D1.1	Structural Welding Code
ANSI A13.1	Scheme for the Identification of Piping Systems
AWWA M11	Steel Pipe Design and Installation Manual
MSS SP	Pipe Hangers and Supports - Materials, Design and Manufacture

1.3 CONTRACTOR SUBMITTALS

- A. Shop Drawings: Submittals shall be furnished in accordance Section 01330 – Submittal Procedures. Shop Drawings shall contain the following information:
 - 1. Drawings: Layout drawings including all necessary dimensions, details, pipe joints, fittings, specials, valves, appurtenances, anchors, guides,

and material lists. Fabrication drawings shall indicate all spool pieces, spacers, adapters, connectors, fittings, and supports to accommodate the equipment and valves in a complete and functional system.

- B. Samples: All expenses incurred in making samples for certification of tests shall be borne by the Contractor at no increase in cost to the Owner.
- C. Certifications:
 - 1. All necessary certificates, test reports, and affidavits of compliance shall be obtained by the Contractor.
 - 2. Fabricator Statement: A statement from the pipe fabricator certifying that all pipes will be fabricated subject to a recognized Quality Control Program. An outline of the program shall be submitted to the Engineer for review prior to the fabrication of any pipe.

1.4 QUALITY ASSURANCE

- A. General: To assure uniformity and compatibility of piping components in grooved-end piping systems, fittings and couplings shall be furnished by the same manufacturer. Like items of materials provided hereunder shall be the end products of one manufacturer in order to achieve standardization for appearance and manufacturer's service.
- B. Inspection:
 - 1. All pipe shall be subject to inspection at the place of manufacture. During the manufacture of the pipe, the Engineer shall be given access to all areas where manufacturing is in progress and shall be permitted to make all inspections necessary to confirm compliance with the Specifications.
 - 2. The Contractor shall notify the Engineer of the production schedule in sufficient time so that factory inspection can be arranged. Factory inspection will be made after the manufacturer has performed satisfactory checks, adjustments, tests, and operations. The extent of factory inspection and testing shall be as specified herein below and in the respective piping sections of these Specifications.
 - 3. The manufacturer shall make available for the Engineers use such gauges as are necessary for inspection. The manufacturer shall provide the Engineer with such assistance as is necessary for the handling of pipe and fittings.
 - 4. Approval of pipe at the factory only allows the manufacturer to ship the equipment to the site and does not constitute final acceptance by the Engineer. Unless otherwise specified, the Owner will pay for expenses incurred for the factory test witness visits. The cost of performing the tests in the factory shall be included in the Contractor's bid.
- C. Welding Requirements. All welding procedures used to fabricate pipe shall be prequalified under the provisions of ANSI/AWS D1.1. Welding procedures shall be required for, but not necessarily limited to, longitudinal and girth or

spiral welds for pipe cylinders, reinforcing plates and ring flange welds, and plates for lug connections.

PART 2 PRODUCTS

2.1 GENERAL

- A. Extent of Work: All pipes, fittings, and appurtenances shall be provided in accordance with the requirements of the applicable Sections of Divisions 2 and 15 and as indicated. The pipe material required for each fluid application shall be in accordance with the Pipe Schedule. Where a pipe material type is not specifically designated on the drawings, the Contractor may select among the options presented in the Pipe Schedule. When a pipe material is specifically designated on the drawings, only that material will be allowed unless approved in writing by the Engineer.
- B. Pipe Supports: All pipes shall be adequately supported, restrained, and anchored in accordance with the requirements of Section 15006 - Pipe Supports, and as indicated. Where pipe support details are indicated, the supports shall conform thereto and shall be placed as indicated; provided, that the support for all exposed piping shall be complete and adequate regardless of whether or not supporting devices are specifically shown.
- C. Lining: Application, thickness, and curing of pipe lining shall be in accordance with the requirements of the applicable Sections of Division 2, unless otherwise indicated. The manufacturer shall take full responsibility for the complete, final product and its application. All pipe ends and joints of lined pipes at screwed flanges shall be epoxy-coated to assure continuous protection.
- D. Protective Coating: Application, thickness, and curing of pipe coating shall be in accordance with the requirements of the applicable Sections of Division 2, unless otherwise indicated. Pipes above ground or in structures shall be field-coated in accordance with Section 09960 – Protective Coatings.
- E. Pressure Rating: All piping systems shall be designed for the maximum expected pressure as defined in Section 02640 - Pipeline Testing and Disinfection, or as indicated on the Piping Schedule.
- F. Core Drilling: Where core drilling is required for pipes passing through existing concrete, core drilling locations shall be determined by radiograph of concrete construction to avoid damage to embedded raceways and rebars.
- G. Welding Requirements: All welding procedures used to fabricate pipe shall be prequalified under the provisions of ANSI/AWS D1.1 - Structural Welding Code. Welding procedures shall be required for longitudinal and girth or spiral welds for pipe cylinders, spigot, and bell ring attachments, reinforcing plates and ring flange welds, and plates for lug connections. All welding shall be done by skilled welders, welding operators, and tackers who have had adequate experience in the methods and materials to be used. Welders shall be qualified under the provisions of ANSI/AWS D1.1 by an independent local, approved testing agency not more than 6 months prior to commencing work

on the pipeline. Machines and electrodes similar to those used in the Work shall be used in qualification tests. The Contractor shall furnish all material and bear the expense of qualifying welders at no increased cost to the Owner.

- H. Care shall be exercised during fabrication to prevent the accumulation of weld rod, weld splatter, pipe cuttings and filings, gravel, cleaning rags, etc., within piping sections. All piping shall be examined to assure removal of these and other foreign objects prior to assembly. Shop cleaning may employ any conventional commercial cleaning method if it does not corrode, deform, swell, or otherwise alter the physical properties of the material being cleaned.

2.2 PIPE FLANGES

- A. Flanges: Where the design pressure is 150 psi or less, flanges shall conform to either ANSI/AWWA C207 - Steel Pipe Flanges for Waterworks Service - Sizes 4 In. Through 144 In., Class D, or ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings, 150-lb class. Where the design pressure is greater than 150 psi up to a maximum of 275 psi, flanges shall conform to either ANSI/AWWA C207 Class E or Class F, or ANSI/ASME B16.5 150-lb class. However, AWWA flanges shall not be exposed to test pressures greater than 125 percent of rated capacity. For higher test pressures, the next higher rated AWWA flange or an ANSI-rated flange shall be selected. Where the design pressure is greater than 275 psi up to a maximum of 700 psi, flanges shall conform to ANSI/ASME B16.5, 300-lb class. Flanges shall have flat faces and shall be attached with bolt holes straddling the vertical axis of the pipe, unless otherwise indicated. Attachment of the flanges to the pipe shall conform to the applicable requirements of ANSI/AWWA C207. The Contractor shall coordinate the flange compatibility for pipes, valves, and equipment. Where connecting to existing flanges, the Contractor shall field verify existing flange dimensions. Flanges for miscellaneous small pipes shall be in accordance with the standards indicated for these pipes.
- B. Blind Flanges: Blind flanges shall be in accordance with ANSI/AWWA C207, or as indicated for miscellaneous small pipes. All blind flanges for pipe sizes 12 inches and over shall be provided with lifting eyes in form of welded or screwed eye bolts.
- C. Flange Bolts: All bolts and nuts shall be provided per "Bolts and Anchors" described below.
- D. Flange Gaskets: Unless specified for specific materials, gaskets for flanged joints shall be full-faced, 1/16-inch thick compressed sheets of aramid fiber base, with nitrile binder and non-stick coating, suitable for temperatures to 700 degrees F, a pH of one to eleven, and pressures to 1,000 psig. Blind flanges shall have gaskets covering the entire inside face of the blind flange and shall be cemented to the blind flange. Ring gaskets shall not be permitted, unless otherwise indicated.

- E. Flange Coating: All machined faces of metal blind flanges and pipe flanges shall be coated with a temporary rust-inhibitive coating to protect the metal until the installation is completed.
- F. Flange Gasket Manufacturers, or Equal:
 - 1. John Crane; Style 2160.
 - 2. Garlock; Style 3000.

2.3 INSULATION FLANGES

- A. Insulating Flange Sets: Insulating flange sets shall be provided where indicated, and as required by Section 13115 - Cathodic Protection System. Each insulating flange set shall consist of an insulating gasket, insulating sleeves and washers and a steel washer. Insulated flanges shall have bolt holes 1/4-inch diameter greater than the bolt diameter. Insulating sleeves and washers shall be one piece when flange bolt diameter is 1-1/2-inch or smaller and shall be made of acetal resin. For bolt diameters larger than 1-1/2-inch, insulating sleeves and washers shall be 2-piece and shall be made of polyethylene or phenolic. Steel washers shall be in accordance with ASTM A325 - Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength. Insulating gaskets shall be full-face.
- B. Insulating Flange Manufacturers, or Equal:
 - 1. JM Red Devil; Type E.
 - 2. Maloney Pipeline Products Co., Houston.
 - 3. PSI Products, Inc., (Frost Engineering Service Co., Costa Mesa, California).

2.4 THREADED INSULATING CONNECTIONS

- A. General: Threaded insulating bushings, unions, or couplings, as appropriate, shall be used for joining threaded pipes of dissimilar metals and for piping systems where corrosion control and cathodic protection are involved.
- B. Materials: Threaded insulating connections shall be of nylon, Teflon, polycarbonate, polyethylene, or other non-conductive materials, and shall have ratings and properties to suit the service and loading conditions.

2.5 MECHANICAL-TYPE COUPLINGS (GROOVED OR BANDED PIPE)

- A. General: Cast mechanical-type couplings shall be provided where indicated. The couplings shall conform to the requirements of ANSI/AWWA C606 - Grooved and Shouldered Joints. Bolts and nuts shall conform to the requirements of Section 05500 - Metal Fabrications. All gaskets for mechanical-type couplings shall be compatible with the piping service and fluid utilized, in accordance with the coupling Manufacturer's recommendations. The wall thickness of all grooved piping shall conform with the coupling manufacturer's recommendations to suit the highest expected pressure. To avoid stress on equipment, all equipment connections with mechanical-type couplings shall have rigid-grooved couplings, or harness

sets in sizes where rigid couplings are not available, unless thrust restraint is provided by other means. All mechanical-type couplings on buried piping shall be bonded. The Contractor shall have the coupling manufacturer's service representative verify the correct choice and application of all couplings and gaskets, and the workmanship, to assure a correct installation. To assure uniform and compatible piping components, all grooved fittings, couplings, and valves shall be from the same manufacturer.

B. Manufacturers of Couplings for Steel Pipe, or Equal:

1. Gustin-Bacon (Aeroquip Corp.) (banded or grooved).
2. Victaulic Style 41 or 44 (banded, flexible).
3. Victaulic Style 77 (grooved, flexible).
4. Victaulic Style 07 or HP-70 (grooved, rigid).

C. Manufacturers of Ductile Iron Pipe Couplings, or Equal:

1. Gustin-Bacon, (Aeroquip Corp.).
2. Victaulic Style 31 (flexible or rigid grooving).

Note: Ductile iron pipe couplings shall be furnished with flush seal gaskets.

D. Manufacturers of Couplings for PVC Pipe, or Equal:

1. Gustin-Bacon, (Aeroquip Corp.).
2. Victaulic Style 775.

Note: Couplings for PVC pipe shall be furnished with radius cut or standard roll grooved pipe ends.

2.6 SLEEVE-TYPE COUPLINGS

A. Construction: Sleeve-type couplings and flange coupling adapters shall be provided, in accordance with ANSI/AWWA C219 - Standard for Bolted Sleeve-Type Couplings for Plain-End Pipe and shall be of powder coated steel with Type 316 stainless steel bolts, without pipe stop, and be of sizes to fit the pipe and fittings indicated. The middle ring shall be not less than 1/4-inch in thickness and shall be either 5 or 7 inches long for sizes up to and including 30 inches and 10 inches long for sizes greater than 30 inches, for standard steel couplings, and 16 inches long for long-sleeve couplings. The followers shall be single-piece contoured mill sections welded and cold-expanded as required for the middle rings, and of sufficient strength to accommodate the number of bolts necessary to obtain adequate gasket pressures without excessive rolling. The shape of the follower shall be of such design as to provide positive confinement of the gasket. Bolts and nuts shall conform to the requirements of Section 05500 – Metal Fabrications. Buried sleeve-type couplings and bolts shall be fusion bonded epoxy-coated at the factory.

B. Pipe Preparation: The ends of the pipe where indicated shall be prepared for flexible steel couplings. Plain ends for use with couplings shall be smooth

and round for a distance of 12 inches from the ends of the pipe, with outside diameter not more than 1/64-inch smaller than the nominal outside diameter of the pipe. The middle ring shall be tested by cold-expanding a minimum of one percent beyond the yield point, to proof-test the weld to the strength of the parent metal. The weld of the middle ring shall be subjected to air test for porosity.

- C. Gaskets: Gaskets for sleeve-type couplings shall be rubber-compound material that will not deteriorate from age or exposure to air under normal storage or use conditions. Gaskets for wastewater and sewerage applications shall be Buna "N," Grade 60, or equivalent suitable elastomer. The rubber in the gasket shall meet the following specifications:
 - 1. Color: Jet Black.
 - 2. Surface: Non-blooming.
 - 3. Durometer Hardness: 74 ± 5 .
 - 4. Tensile Strength: 1,000 psi minimum.
 - 5. Elongation: 175 percent minimum.
 - 6. The gaskets shall be immune to attack by impurities normally found in water or wastewater. All gaskets shall meet the requirements of ASTM D2000 - Classification System for Rubber Products in Automotive Applications, AA709Z, meeting Suffix B13 Grade 3, except as noted above. All gaskets shall be compatible with the piping service and fluid utilized.
- D. Insulating Couplings: Where insulating couplings are required, both ends of the coupling shall have a wedge-shaped gasket which assembles over a rubber sleeve of an insulating compound in order to obtain insulation of all coupling metal parts from the pipe.
- E. Restrained Joints: All sleeve-type couplings on pressure lines shall be harnessed, unless thrust restraint is provided by other means. Harnesses shall be in accordance with the appropriate reference standard, or as indicated.
- F. Sleeve Type Coupling Manufacturers, or Equal:
 - 1. Dresser, Style 38.
 - 2. Smith-Blair, Style 411.

2.7 FLANGE COUPLING ADAPTERS

- A. Flange adapters shall be fabricated from high strength steel. Flanges shall be supplied to AWWA C207, as well as all ANSI standards. Compression ends shall have wedge gasket for efficient sealing. Gasket material shall be suitable for raw wastewater. All miscellaneous metalwork items shall be Type 316 stainless steel.
- B. Pipe ends shall be properly prepared for accepting the flange adapter in accordance with manufacturer's recommendations. The outside diameter and pipe type shall be verified prior to ordering adapters. Flange adapters shall be

lined and coated with fusion bonded epoxy as specified in Section 09960 – Protective Coatings.

- C. Where cement mortar coated pipe is to be provided with sleeve type couplings, cement mortar coatings shall be heldback for coupling. Pipe shall be epoxy coated at location of coupling and cement mortar coating intersection.
- D. Flange Adapters Shall Be Manufactured By, or Equal:
 - 1. Dresser; Style 128.
 - 2. Smith-Blair.

2.8 FLEXIBLE CONNECTORS

- A. Flexible connectors shall be installed in all piping connections to engines, blowers, compressors, and other vibrating equipment, and where indicated. Flexible connectors for service temperatures up to 180 degrees F shall be flanged, reinforced Neoprene or Butyl spools, rated for a working pressure of 40 to 150 psi, or reinforced, flanged duck and rubber, as best suited for the application. Flexible connectors for service temperatures above 180 degrees F shall be flanged, braided stainless steel spools with inner, annular, corrugated stainless steel hose, rated for minimum 150 psi working pressure, unless otherwise indicated. The connectors shall be a minimum of 9 inches long, face-to-face flanges, unless otherwise indicated. The final material selection shall be approved by the manufacturer. The Contractor shall submit manufacturer's shop drawings and calculations.

2.9 EXPANSION JOINTS

- A. All piping subject to expansion and contraction shall be provided with sufficient means to compensate for such movement without exertion of undue forces to equipment or structures. This may be accomplished with expansion loops, bellow-type expansion joints, or sliding-type expansion joints. Expansion joints shall be of stainless steel, monel, rubber, or other materials, best suited for each individual service. The Contractor shall submit detailed calculations and manufacturer's shop drawings of all proposed expansion joints, piping layouts, and anchors and guides, including information on materials, temperature, and pressure ratings.
- B. For aeration air pipe provide metal expansion joint with non-controlled, hydroformed, high-corrugation stainless steel bellows. Shall be suitable for a maximum operating pressure of 50 psi as required by the system, and a temperature rating of 300 degrees F. Joints shall have an expansion/compression of plus/minus 3" or as required by the system, and have ANSI class 150 flanges, or grooved.
- C. Sliding-type expansion joints shall have flanged ends and limit rods.

2.10 RUBBER FLEXIBLE CONNECTORS (FABRIC REINFORCED)

- A. Flexible connectors shall be provided on the suction and discharge side of each pump, except sump pumps, and where shown on the Drawings. Where shown, flexible connectors shall be reducing, and/or eccentric.
- B. Flexible connectors shall be fabric reinforced neoprene with 125-pound flanged ANSI end connections rated for 100 psi cold water service. The connectors shall have filled arches specifically for wastewater service. The connectors shall provide a minimum of 1/4-inch axial compression, 1/8-inch extension, 1/4-inch lateral deflection, and 2 degrees angular flexibility. All units shall be suitable for vibration and connection to pumping units. Units shall be manufactured by, or approved equal:
 - 1. Holz Rubber Company, Inc.
 - 2. Garlock.
 - 3. Red Valve Company, Inc. – Redflex.
- C. Each flexible connector shall be furnished and installed with harness bolt control units to prevent joint separation due to hydraulic pressure. Number and size of Type 316 stainless steel harness bolts shall be as necessary to withstand test pressures plus 50 psi surge. The internal materials of the flexible connectors shall be resistant to wastewater. Flexible connector to be used outdoors shall have a cover coating to provide extra product protection against ultra-violet radiation, ozone, weather, and the environment, and shall be suitable for outdoor use.

2.11 PIPE THREADS

- A. All pipe threads shall be in accordance with ANSI/ASME B1.20.1 - Pipe Threads, General Purpose (inch), made up with Teflon tape, unless otherwise indicated.

2.12 PIPE INSULATION

- A. Hot and cold liquid piping, flues, and engine exhaust piping shall be insulated as shown, in accordance with the requirements indicated. No unprotected hot piping shall be within reach of operating personnel or other persons.

2.13 CATHODIC PROTECTION

- A. Where so indicated, buried piping shall be cathodically protected in accordance with Section 16640 - Cathodic Protection.

2.14 AIR AND GAS TRAPS

- A. Air and gas pipes shall be sloping to low points, provided with drip legs, shut-off valves, strainers, and traps. The traps shall be piped to the nearest drain. Air and gas traps shall be not less than 150-lb iron body float type with copper or stainless steel float. Bracket, lever, and pins shall be of stainless steel. Drain traps shall have threaded connections.

B. Manufacturers, or Equal:

1. Armstrong International, Inc.
2. Spirax Sarco, Inc.

2.15 BOLTS AND ANCHORS

- A. Standard Service (Non-Corrosive Application): Unless otherwise indicated, bolts, anchor bolts, washers, and nuts shall be steel, galvanized after fabrication as indicated herein. Threads on galvanized bolts and nuts shall be formed with suitable taps and dies such that they retain their normal clearance after hot-dip galvanizing. Except as otherwise indicated, carbon steel bolts, anchor bolts and cap screws shall be in accordance with the requirements of ASTM A307, Grade B where working pressures are 175 psi or less. For higher pressures, bolt material shall conform to the requirements of ASTM A193, Grade B7.
- B. Corrosive Service: Bolts, nuts, and washers in the locations listed below shall be stainless steel as indicated below.
1. Buried locations.
 2. Submerged locations.
 3. Locations subject to seasonal or occasional flooding.
 4. Inside hydraulic structures below the top of the structure.
 5. Inside buried vaults, manholes, and structures that do not drain through a gravity sewer or to a sump with a pump.
 6. Chemical handling areas.
 7. Inside trenches, containment walls, and curbed areas.
 8. Locations indicated by the Contract Documents or designated by the Engineer to be provided with stainless steel bolts.
- C. Unless otherwise indicated, stainless steel bolts, anchor bolts, nuts, and washers shall be Type 316 stainless steel in accordance with ASTM A193, Class 2, Grade 8M or ASTM F593, Condition SH. Threads on stainless steel bolts shall be protected with an antiseize lubricant suitable for submerged stainless steel bolts, to meet government specification MIL-A-907E. Buried bolts shall be coated as specified in Section 13115 – Cathodic Protection System.
1. Antiseize lubricant shall be classified as acceptable for potable water use by the NSF.
 2. Antiseize lubricant shall be "Pure White" by Anti-Seize Technology, Franklin Park, IL; or equal.
- D. Bolt Requirements:
1. The bolt and nut material shall be free-cutting steel.
 2. The nuts shall be capable of developing the full strength of the bolts. Threads shall be Coarse Thread Series conforming to the requirements of the American Standard for Screw Threads. Bolts and cap screws shall have hexagon heads and nuts shall be Heavy Hexagon Series.
 3. Bolts and nuts shall be installed with washers fabricated of material matching the base material of bolts, except that hardened washers for high strength bolts shall conform to the requirements of the AISC Specification. Lock washers shall be installed with washers where indicated and shall be fabricated of material matching the bolts.

4. The length of bolts shall be such that after joints are made up, each bolt shall extend through the entire nut, but in no case more than 1/2-inch beyond the nut.
5. All-thread studs shall be used on valve flange connections, where space restrictions preclude the use of regular bolts.

PART 3 EXECUTION

3.1 MATERIAL DELIVERY, STORAGE, AND PROTECTION

- A. All piping materials, fittings, valves, and accessories shall be delivered in a clean and undamaged condition and stored off the ground for protection against oxidation caused by ground contact. All defective or damaged materials shall be replaced with new materials.

3.2 INSTALLATION

A. General:

1. All pipes, fittings, and appurtenances shall be installed in accordance with the requirements of the applicable Sections of Divisions 2 and 15.
2. Each pipe and fitting shall be carefully inspected before the exposed pipe or fitting is installed or the buried pipe or fitting is lowered into the trench. The laying of all pipe shall be in finished trenches free from water or debris. The lining and protective coating shall be inspected, and all damaged areas patched in the field with material similar to the original. Clean ends of pipe thoroughly. Remove foreign matter and dirt from inside of pipe and keep clean during and after laying.
3. Clean out fittings, valves, and pipe sections before installing.
4. Furnish and assemble pipe and fittings to provide accurate alignment for joints.
5. Make all joints watertight.
6. Use an anti-seize compound on all bolt threads. Manufacturer's instruction for application shall be followed. The anti-seize compound shall be designed to prevent rusting and seizure of bolt threads and to prevent galling of stainless steel.
7. Provide temporary plugs or bulkheads for closure of the open ends of piping whenever work is stopped.
8. Use proper implements, tools, and facilities for the safe and proper protection of the pipe. Carefully handle pipe in such a manner as to avoid any physical damage to the pipe. Do not drop or dump pipe into trenches under any circumstances.
9. In laying pressure pipelines, the deflection in a standard joint shall not exceed the manufacturer's recommendation. Deflections of more than 5 degrees shall require special bends or fittings. Departure from and return to established alignment and grade shall not exceed 1/16-inch per linear foot of pipe, and at no point shall the maximum departure from established line and grade be greater than 1-inch.
10. Each section of pipe shall be lowered into the trench, utilizing a sling or other device, in a manner that shall prevent injury to the pipe, coating, lining, or joints. In placing pipe in the trench, the pipe shall be held by

the lowering device at the balancing point of the section. It shall not be dragged on the bottom of the trench but shall be supported while being fitted into the adjacent section. Supporting the pipe on blocks, or blocking of any nature, either temporary or otherwise, will not be allowed.

11. It is the responsibility of the Contractor, when the pipeline and appurtenances are finally laid, to see that all joints are protected and that any damage to the coating or lining of the pipe and fittings has been adequately repaired or replaced in order to preserve their integrity for corrosion protection.
12. Repairs of defects that are discovered as a result of inspection or tests shall be made with new materials. Caulking of screwed joints, cracks, or holes will not be accepted. Tests shall be repeated after defects have been eliminated.
13. After completion of the work, all remaining pipe cuttings, joining and wrapping materials, and other scattered debris, shall be removed from the site. The entire piping system shall be handed over in a clean and functional condition.
14. Following assembly and testing, but prior to final acceptance, all pipelines shall be flushed with high velocity water or flushed with a cleaning ball. All accumulated construction debris and other foreign matter shall be removed. Flushing velocities shall be a minimum of 2.5 feet per second. Accumulated debris shall be removed through drains 2 inches and larger or by dropping spools and valves.
15. The Piping Schedule lists the pressures at which all lines shall be tested.

B. Exposed Pipe:

1. Where not detailed, exposed pipe shall be installed in straight runs parallel to the axes of the structures. Pipe runs shall be horizontal and vertical, except that gravity lines shall have a minimum slope of not less than 0.5 percent, unless otherwise specified.
2. No exposed piping shall be erected until all equipment to which the pipe is to be attached has been installed and it can be determined where piping and fittings shall be located to make a neat, efficient arrangement.
3. The Contract Documents shall be taken as diagrammatic for piping that is not shown in detail. Sizes of piping and their locations are indicated, but it is not intended to show every offset and fitting nor every structural difficulty that will be encountered during the installation of the Work.
4. The alignment of pipes shall be varied from that indicated on the Contract Documents, without extra expense to the Owner where necessary to avoid structural or mechanical difficulties or to avoid the work of any other trades. The Contractor shall furnish such parts and pieces as may be necessary to provide a complete and operable system.
5. Pipe work shall be suspended and supported in such 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.

6. 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.
7. Piping shall be made up with a sufficient number of unions or flanged joints to permit ready breaking of lines as necessary for inspection and maintenance, in addition to such joints as are definitely shown on the Drawings.

3.3 TESTING

- A. All piping shall be tested in accordance with the requirements of Section 02640 – Pipeline Testing and Disinfection.

END OF SECTION

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SECTION 15005 – PIPING IDENTIFICATION SYSTEMS

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall furnish, mark, and install identification devices for all exposed piping using painting, lettering, flow direction arrows, and related permanent identification devices, and all appurtenant works, in accordance with the requirements of the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Commercial Standards:

ANSI A13.1 Scheme for the Identification of Piping Systems.

1.3 CONTRACTOR SUBMITTALS

- A. Product Data: Submit manufacturer's catalog literature for each product required.
- B. Samples: The Contractor shall submit samples of all types of identification devices to be used in the work to the Engineer, for approval prior to fabrication.
- C. The Contractor shall submit to the Engineer, for approval, a list of suggested wording for all valve tags prior to fabrication.
- D. All submittals shall be in strict accordance with the requirements of Section 01330 – Submittal Procedures.

PART 2 PRODUCTS

2.1 IDENTIFICATION OF PIPING

- A. Identification of all exposed pipe shall be accomplished by color-coding with painting and by lettering as specified in Part 3, herein, and in Section 09960 – Protective Coatings.
- B. Each pipe identification shall consist of painting, a printed label identifying the name of the pipe, and a flow arrow to indicate direction of flow in the pipe. All labels shall be preprinted on pressure-sensitive adhesive-backed vinyl cloth or plastic tape. Arrows shall be die-cut of the same type of material as the labels.
- C. Letter sizes and colors for lettering, arrows, and background shall conform to ANSI A13.1.
- D. Preprinted identification devices shall be as manufactured by:
 - 1. W. H. Brady Co.
 - 2. Seton Nameplate Corp., or equal.

2.2 EXISTING IDENTIFICATION SYSTEMS

- A. In installations where existing piping identification systems have been established, the Contractor shall continue to use the existing system. Where existing identification systems are incomplete, utilize the existing system as far as practical and supplement with the specified system. The objective is to fully identify all new piping, valves, and appurtenances to the level specified herein.

2.3 IDENTIFICATION OF SHORT PIPE LENGTHS

- A. Identifying devices for sections of pipe that are too short to be identified with painting, lettered labels, and arrows shall be identified with metal or plastic tags as specified herein.
- B. Metal tags shall be of stainless steel with embossed lettering. Plastic tags shall be of solid black plastic laminate with white embossed letters. All tags shall be designed to be firmly attached to the short pipes or to the structure immediately adjacent to such short pipes.
- C. Factory-fabricated, flexible, semi-rigid vinyl, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener.

PART 3 EXECUTION

3.1 INSTALLATION

- A. All labels and identification tags shall be installed in accordance with the manufacturer's printed instructions and shall be neat and uniform in appearance. All such tags or labels shall be readily visible from all normal working locations.

B. VALVE TAGS

- 1. Valve tags shall be permanently attached to the valve or structure by means of 2 stainless steel bolts or screws. The wording on the valve tags shall describe the exact function of each valve, e.g., "HWR-BALANCING," "FA-THROTTLING", "3W-PUMP SHUT-OFF," etc.
- 2. Install tags using corrosion-resistant chain. Number tags consecutively by location.

C. PIPE IDENTIFICATION

- 1. All unburied pipe, pipe in structures, and pipe in chemical pipe trenches shall be color-coded painted. The color code painting shall include all valves, supports, equipment and appurtenances to the piping system. Each pipe shall be labeled at intervals of 20 feet, and at least one time in each room. Piping shall also be identified at a point approximately within 2 feet of all turns, ells, valves, and on the upstream side of all distribution fittings or branches. Sections of pipe that are too short to be identified with painting, lettered labels, and directional arrows shall be tagged and identified similar to valves.

2. Pipe identification shall consist of 3 elements, i.e., painting, a lettered label, and a directional label.

3.2 IDENTIFICATION SCHEDULE

- A. Application of identifying devices shall conform to the following color codes:

Fluid Abbreviation	Function and Identification	Identification Color
1W	POTABLE WATER	safety blue
2W	NON-POTABLE WATER	green
3W	TREATED PLANT EFFLUENT	purple
BW	BACKWASH WATER	brown
CA	COMPRESSED AIR	safety yellow
CLS	CHLORINE SOLUTION, HYPOCHLORITE	safety yellow
D	DRAIN	brown
DG	DIGESTER GAS	yellow
DS	DIGESTED SLUDGE	brown
EA	EXHAUST AIR	yellow
EQR	EQUALIZATION BASIN RETURN	gray
EQR	EQUALIZATION BASIN SUPPLY	gray
FA	FOUL AIR	light gray
FC	FERRIC CHLORIDE	safety green
FE	FINAL EFFLUENT	purple
FI	FILTER INFLUENT	purple
FOR	DIESEL FUEL OIL RETURN	orange
FOS	DIESEL FUEL OIL SUPPLY	orange
FT	FILTRATE	brown
G	GRIT	brown
HWR	HOT WATER RETURN	light blue
HWS	HOT WATER SUPPLY	light blue
IA	INSTRUMENT AIR	white
NG	NATURAL GAS	yellow
OF	OVERFLOW	same as corresponding fluid
P	POLYMER (LIQUID)	orange
PD	PUMPED DRAIN	brown
PE	PRIMARY EFFLUENT	gray
PI	PRIMARY INFLUENT	gray
PS	PRIMARY SLUDGE	brown
PS/SCUM	PRIMARY SLUDGE/SCUM	brown
R	PLANT DRAINAGE RETURN	brown
RW	RECYCLED WATER	purple
S	SEWER	brown
SC	SCREENINGS	brown
SCUM	SCUM	brown
SD	STORM DRAIN	gray
SE	SECONDARY EFFLUENT	light blue

Fluid Abbreviation	Function and Identification	Identification Color
SG	SLUDGE GAS	yellow
SLUDGE	SLUDGE	brown
SS	SANITARY SEWER	gray
SW	SEAL WATER	purple
TS	THICKENED SLUDGE	brown
TWAS	THICKENED WASTE ACTIVATED SLUDGE	brown
V	VENT	same as corresponding fluid
WS	WASTE SLUDGE	brown

END OF SECTION

SECTION 15006 – PIPE SUPPORTS

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall provide pipe supports, hangers, guides, and anchors, complete, in accordance with the Contract Documents. The pipe supports indicated on the Drawings generally reference standard details, which are representative of industry standards. Not all the supports required for a complete installation are shown, or specifically called out. The Contractor shall provide all the necessary supports required for all the loads imposed on the piping system, including gravity, seismic, thermal, and pressure. The support systems shall include lateral bracing for seismic loads, and anchor bracing for thermal expansion/contraction.
- B. Generally locations of pipe supports, hangers, guides, and anchors are shown. The Contractor is ultimately responsible for meeting requirements of this Specification including locating and providing of all the necessary supports for seismic and wind loads.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. AISC
- B. ASTM A123
- C. ANSI/ASME B31.1

1.3 CONTRACTOR SUBMITTALS

- A. General: Submittals shall be in accordance with Section 01330 – Submittal Procedures.
- B. Shop Drawings: Shop drawings shall include the following information:
 - 1. Drawings of location plan, pipe supports, hangers, anchors, and guides.
 - 2. Calculations for special supports and anchors, including seismic and anchorage design stamped and sealed by a Professional Engineer in the State of California.
 - 3. Catalog Cut Sheets: Submit manufacturers catalog data including load capacity.

1.4 QUALITY ASSURANCE

- A. Pipe hangers and supports shall be fabricated and installed by experienced welders and fitters, using the best welding procedures available. Fabricated supports shall be neat in appearance without sharp corners, burrs, and edges.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Code Compliance: All piping systems and pipe connections to equipment shall be properly anchored and supported to prevent undue deflection, vibration, dislocation due to seismic events and line pressures, and stresses on piping, equipment, and structures. All supports and parts thereof shall conform to the requirements of ANSI/ASME B31.1 - Power Piping, except as supplemented or modified below. Supports for plumbing piping shall be in accordance with the latest edition of the applicable plumbing code or local administration requirements.
1. All pipe supports and restraints shall be designed to support their respective pipes under the maximum combination of peak loading conditions, including pipe weight, liquid weight, liquid movement, pressure forces, thermal expansion and contraction, vibrations, and all probable externally applied forces, including but not limited to seismic forces, wind forces and forces applied during construction.
 2. The Contractor shall note that the pipe support details in the Drawings need to work as a system to resist seismic and wind forces. The Contractor shall install lateral supports as needed to resist the seismic and wind forces given on the Structural Drawings. For special supports not defined in the Contract documents, the Contractor shall submit design calculations, shall be submitted to the Engineer in accordance with Section 01300 – Submittals.
- B. Structural Members: Wherever possible, pipes shall be supported from structural members. Where it is necessary to frame structural members between existing members, such supplementary members shall be provided by the Contractor at no additional cost to the Owner. All supplementary members shall be in accordance with the requirements of the building code and the American Institute of Steel Construction and shall be acceptable to the Engineer.
- C. Pipe Hangers: Pipe hangers shall be capable of supporting the pipe in all conditions of operation, allowing free expansion and contraction of the piping, and preventing excessive stress on equipment. All hangers shall have a means of vertical adjustment after erection. Hangers shall be designed to prevent becoming disengaged by any movement of the supported pipe. Hangers subject to shock, seismic disturbances, or thrust imposed by the actuation of safety valves, shall include hydraulic shock suppressors. All hanger rods shall be subject to tensile loading only.
- D. Hangers Subject to Horizontal Movements: At hanger locations where lateral or axial movement is anticipated, suitable linkage shall be provided to permit such movement. Where horizontal pipe movement is greater than 1/2 inch, or where the hanger rod deflection from the vertical is greater than 4 degrees from the cold to the hot position of the pipe, the hanger rod and structural attachment shall be offset in such a manner that the rod is vertical in the hot position.
- E. Spring-Type Hangers: Spring-type pipe hangers shall be provided for piping subject to vibration or vertical expansion and contraction, such as engine exhausts and similar piping. All spring-type hangers shall be sized to the manufacturer's printed recommendations and the loading conditions encountered. Variable spring supports shall be provided with means to limit misalignment, buckling, eccentric

loading, or to prevent overstressing of the spring, and with means to indicate at all times the compression of the spring. Supports shall be capable of accommodating at least 4 times the maximum travel due to thermal expansion.

- F. Thermal Expansion: Wherever expansion and contraction of piping is expected, a sufficient number of expansion loops or joints shall be provided, together with the necessary rolling or sliding supports, anchors, guides, pivots, and restraints permitting the piping to expand and contract freely in directions away from the anchored points. All components shall be structurally suitable to withstand all loads imposed.
- G. Heat Transmission: Supports, hangers, anchors, and guides shall be so designed and insulated, that excessive heat will not be transmitted to the structure or to other equipment.
- H. Riser Supports: Where practical, risers shall be supported on each floor with riser clamps and lugs, independent of the connected horizontal piping.
- I. Freestanding Piping: Free-standing pipe connections to equipment such as chemical feeders and pumps shall be firmly attached to steel frames fabricated from angles, channels, or I-beams anchored to the structure. Exterior, free-standing overhead piping shall be supported on fabricated pipe stands consisting of pipe columns anchored to concrete footings, with horizontal, welded steel angles and U-bolts or clamps securing the pipes.
- J. Point Loads: Any meters, valves, heavy equipment, and other point loads on PVC, FRP, and other plastic pipes, shall be supported on both sides, according to manufacturer's recommendations to avoid undue pipe stresses and failures. To avoid point loads, all supports on PVC, FRP, and other plastic piping shall be equipped with extra wide pipe saddles or Type 316 stainless steel shields.
- K. Noise Reduction: To reduce transmission of noise in piping systems, all copper tubes in buildings and structures shall be wrapped with a 2-inch wide strip of rubber fabric or similar, suitable material at each pipe support, bracket, clip, or hanger.
- L. Stock Parts: Where not specifically indicated, stock or production parts shall be utilized wherever possible. Such parts shall be locally available, new, of best commercial quality, designed and rated for the intended purpose.

2.2 MATERIALS OF CONSTRUCTION:

- A. General: All pipe support assemblies, including framing, hardware, and anchors, shall be Type 316 stainless steel construction, unless otherwise indicated. Reference to standard details with carbon steel elements shall be constructed of stainless steel.
- B. Submerged Supports: All submerged piping, as well as piping, conduits, and equipment in hydraulic structures below the top of the wall or within 36 inches of the water level, shall be supported with assemblies, including framing, hardware, and anchors, constructed of Type 316 stainless steel, unless otherwise indicated. Reference to standard details with carbon steel elements shall be constructed of stainless steel for these conditions.

- C. Corrosive: All piping in chemical and corrosive areas shall be supported with support assemblies, including framing, hardware, and anchors, constructed of Type 316 stainless steel or FRP, unless otherwise indicated.

2.3 SUPPORT SPACING

- A. Supports for piping with the longitudinal axis in approximately a horizontal position shall be spaced to prevent excessive sag, bending, and shear stresses in the piping, with special consideration given where components such as flanges and valves impose concentrated loads. Pipe support spacing shall not exceed the maximum spans in the tables below. For temperatures other than ambient temperatures, or those listed, and for other piping materials or wall thicknesses, the pipe support spacings shall be modified in accordance with the pipe manufacturer's recommendations. Vertical supports shall be provided to prevent the pipe from being overstressed from the combination of all loading effects.

1. Support Spacing for Steel Pipe:

Nominal Pipe Diameter (inches)	Maximum Span (feet)
1/2	6
3/4 and 1	8
1-1/4 to 2	10
3	12
4	14
6	17
8 and 10	19
12 and 14	23
16 and 18	25
20 and Greater	30

2. Support Spacing for Welded Fabricated Steel Pipe:

a. Maximum Spans for Pipe Supported in Minimum:

1) 120 degree Contact Saddles (feet).

Nominal Pipe Diameter (inches)	Wall Thickness (inches)									
	3/16	1/4	5/16	3/8	7/16	1/2	5/8	3/4	7/8	1
24	33	37	41	43	45	47				
26	34	38	41	44	46	48				
28	34	38	41	44	47	49				
30	34	38	42	45	48	49				
32	34	39	42	45	48	50				
34	35	39	43	46	48	50				
36	35	39	43	46	49	51	55			
38	35	39	43	46	49	51	55			
40	35	40	43	47	49	52	56			
42	35	40	44	47	50	52	56			

3. For steel pipe sizes not presented in this table, the support spacing shall be designed so that the stress on the pipe does not exceed 5,000 psi. Maximum deflection of pipe shall be limited to 1/360th of the span and shall be calculated by using the formula:

$$L = \sqrt{\frac{7500tD}{32t + D}}$$

where:

t = Thickness (inches)

D = Diameter (inches)

L = Maximum span (feet)

4. Support Spacing for Ductile-Iron Pipe:

Nominal Pipe Diameter (inches)	Maximum Span (feet)
All Diameters	Two supports per pipe length or 10 feet (one of the 2 supports located at joint)

5. Support Spacing for Copper Tubing:

Nominal Pipe Diameter (inches)	Maximum Span (feet)
1/2 to 1-1/2	6
2 to 4	10
6 and Greater	12

6. Support Spacing for Schedule 80 PVC Pipe:

Nominal Pipe Diameter (inches)	Maximum Span at 100 degrees F (feet)
1/2	4
3/4	4.5
1	5
1-1/4	5.5
1-1/2	5.75
2	6.25
3	7.5
4	8.25
6	10
8	11
10	12.25
12	13.25

7. Support Spacing for Schedule 80 Polypropylene Pipe:

Nominal Pipe Diameter (inches)	Maximum Span at 100 degrees F (feet)
1/2	3
3/4	3.5
1	3.75
1-1/4	4
1-1/2	4.25
2	4.5
3	5.5
4	6
6	7.25
8	8
10	8.75
12	9.5

8. Support Spacing for Fiberglass Reinforced Plastic (FRP) Pipe:

Nominal Pipe Diameter (inches)	Maximum Span at 100 degrees F (feet)
2	8.8
3	10
4	11
6	12.7
8	13.4
10	14
12	15.4
14	16.2
16	17.3
18 and Greater	18

2.4 PROTECTIVE COATING

- A. Galvanizing: Unless otherwise indicated, all fabricated pipe supports other than stainless steel or non-ferrous supports shall be blast-cleaned after fabrication and hot-dip galvanized in accordance with ASTM A123 - Specifications for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- B. Other Coatings: Other than stainless steel, non-ferrous, or galvanized supports, all supports shall receive protective coatings in accordance with the requirements of Section 09960 – Protective Coatings.

2.5 MANUFACTURERS, OR EQUAL

1. Basic Engineers Inc., Pittsburgh, PA.
2. Bergen-Paterson Pipesupport Corp., Woburn, MA.

3. Grinnell Corp. (Supply Sales Company), Cranston, RI.
4. NPS Products, Inc., Westborough, MA.
5. Power Piping Company, Pittsburgh, PA.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. The CONTRACTOR shall prepare and load all material and articles for shipment in a manner that protects the parts and coatings from damage in transit, shall include a packing list, and shall be responsible for and make good on any and all damage.

3.2 INSTALLATION

- A. General: All pipe supports, hangers, brackets, anchors, guides, and inserts shall be fabricated and installed in accordance with the manufacturer's printed instructions and ANSI/ASME B31.1 - Power Piping. All concrete inserts for pipe hangers and supports shall be coordinated with the formwork.
- B. Appearance: Pipe supports and hangers shall be positioned to produce an orderly, neat piping system. All hanger rods shall be vertical, without offsets. Hangers shall be adjusted to line up groups of pipes at the proper grade for drainage and venting, as close to ceilings or roofs as possible, without interference with other work.
- C. Provide clearance in hangers and from structure and other equipment for installation of insulation.

END OF SECTION

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SECTION 15036 – COPPER PIPE

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall furnish and install all copper pipe and all appurtenant work, complete and in place, including connection to existing and new structures in accordance with the requirements of the Contract Documents.
- B. All pipe specified under this Section shall conform to the requirements of Section 15000 – Piping, General.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. All work shall be performed in strict conformance with the industry standards, local laws, and ordinance specified in the General Requirements. Wherever the requirements of the specifications exceed those of these codes, the requirements of the specifications shall govern. Code compliance is mandatory. Nothing in these Contract Documents shall be construed as permitting work not in accordance with these laws and codes.
- B. Commercial Standards: In case of conflict between the requirements of this Section and those of the listed requirements the more stringent requirement shall be conformed to. The latest edition of the following references at the time of bid shall be used.

ANSI B16.22	Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ANSI B16.26	Cast Copper Alloy Fittings for Flared Copper Tubes
ASTM B32	Solder Metal
ASTM B75	Seamless Copper Tube
ASTM B88	Seamless Copper Water Tube
Uniform Building Code	

1.3 CONTRACTOR SUBMITTALS

- A. For the materials and equipment items supplied under the provisions of this Section, the Contractor shall submit copies of the manufacturer's product specifications and performance details according to the requirements of Section 01330 -Submittal Procedures and the follow supplemental requirements:
 - 1. List of pipe and fittings to be used
 - 2. Manufacturer
 - 3. Model Number
 - 4. Size and Schedule

- 5. Material
 - 6. Pressure Rating
 - 7. Catalogue data
 - 8. Drawings

- B. Shop Drawings: The Contractor shall submit detailed pipe fabrication drawings showing pipe details, special fittings and bends, dimensions, coatings, and other pertinent information. Layout drawings shall also be submitted showing location of each pipe section and each special length. Each pipe shall be numbered in installation sequence and the pipe pressure class shall be indicated.
- C. Manufacturer's written Quality Assurance/Control Program.
- D. Certifications: The Contractor shall furnish a certified affidavit of compliance for all pipe and other products or materials furnished under this Section of the Specifications, as specified in the referenced standards.

1.4 QUALITY ASSURANCE

- A. Inspection: All pipe shall be subject to inspection at the place of manufacture in accordance with the requirements of the applicable referenced standards as supplemented by the requirements herein. The Contractor shall notify the Engineer in writing of the manufacturing starting date not less than 14 calendar days prior to the start of any phase of the pipe manufacture.
- B. During the manufacture of the pipe, the Engineer shall be given access to all areas where manufacturing is in process and shall be permitted to make all inspections necessary to confirm compliance with the Specifications
- C. Tests: Unless otherwise specified, all material used in the manufacture of the pipe shall be tested in accordance with the requirements of the applicable referenced standards.
- D. The Contractor shall perform all material tests at no additional costs to the Owner. The Engineer shall have the right to witness all testing conducted by the Contractor provided that the Contractor's schedule is not delayed for the convenience of the Engineer. In addition to those tests specifically required, the Engineer may request additional samples of any material for testing by the Owner. The additional samples shall be furnished at no additional cost to the Owner.

PART 2 PRODUCTS

2.1 GENERAL

- A. The manufacturer shall legibly mark all pipes and specials in accordance with the laying schedule and marking diagram. Each pipe shall be numbered in sequence and said number shall appear on the laying schedule and marking diagram in its proper location for installation. All pipe sections and fittings shall be marked at each end with top field centerline.

2.2 PIPE MATERIAL

- A. Copper pipe shall be hard drawn and shall conform to the requirements of ASTM B42 - Specification for Seamless Copper Pipe, Standard Sizes, with regular or extra strong wall thickness, as indicated in the Piping Schedule.
- B. Copper water tube shall conform to the requirements of ASTM B88 - Seamless Copper Water Tube and shall be soft temper tube in rolls for buried locations, or hard drawn lengths for all other applications. Unless otherwise indicated, all copper water tube shall be of Type K wall thickness.

2.3 PIPE JOINTS

- A. Copper water tube shall have either: soldered joints, flared ends and fittings, or compression type joints. Soldered joints shall be made with 95 – 5 percent tin-antimony solder or with silver solder. Buried piping shall have flared or compression type joints. No soft-soldered joints will be allowed on buried piping. No solders containing more than 0.2 percent of lead shall be used. Copper pipe shall have screwed ends for NPT fittings or brazed joints. Screwed joints shall be made up with Teflon tape. Brazed or screwed joints may be used in connection with flanges and flanged fittings.

2.4 FITTINGS

- A. Threaded Fittings: Threaded cast bronze fittings for copper pipe shall be in accordance with ANSI/ASME B16.15 - Cast Bronze Threaded Fittings, Classes 125 and 250, as indicated in the Piping Schedule.
- B. Flanged Fittings: Cast copper alloy flanges and flanged fittings shall be in accordance with ANSI/ASME B16.24 - Cast Copper Alloy Pipe Flanges and Flanged Fittings, and ASTM B62 - Composition Bronze or Ounce Metal Castings, with 150 lb rating, or as indicated.
- C. Flared Fittings: Flared fittings shall conform to ANSI/ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
- D. Compression Fittings: Compression type fittings shall be brass fittings as manufactured by:
 - 1. Crawford Company; SWAGELOK.
 - 2. Parker-Hannifin; CPI.
 - 3. Or equal.

2.5 PROTECTIVE COATING

- A. The exterior surfaces of pipe which will be exposed to the atmosphere inside structures or above ground shall be thoroughly cleaned and then given a shop coat of primer compatible with the finish coating required by Section 09960 – Protective Coatings.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. Delivery and storage of steel pipe and appurtenances shall be in accordance with Section 15000 – Piping, General.

- B. The pipe shall be handled as a minimum at the 1/3 points by use of wide slings, padded cradles, or other devices designed and constructed to prevent damage to the pipe coating/exterior. The use of chains, hooks, or other equipment which might injure the pipe coating/exterior will not be permitted. Stockpiled pipe shall be supported on sand or earth berms free of rock exceeding 3 inches in diameter. The pipe shall not be rolled and shall be secured to prevent accidental rolling. All pipe handling equipment and methods shall be acceptable to the Engineer. The Contractor shall be fully liable for the cost of replacement or repair of pipe which is damaged.

3.2 INSTALLATION

- A. General: All copper pipes shall be installed in a neat and workmanlike manner, properly aligned, and cut from measurements taken at the site to avoid interferences with structural members, architectural features, openings, and equipment. Exposed pipes shall afford maximum headroom and access to equipment, and where necessary, all piping shall be installed with sufficient slopes for venting or drainage of liquids and condensate to low points. All installations shall be acceptable to the Engineer.
- B. Pipe Preparation: Prior to installation, each pipe length shall be carefully inspected, be flushed clean of any debris or dust, and be straightened if not true. Ends of threaded pipes shall be reamed and filed smooth. All pipe fittings shall be equally cleaned before assemblage.
- C. The Contractor shall inspect each pipe and fitting to insure that there are no damaged portions of the pipe. The Contractor shall remove or smooth out any burrs, gouges, weld splatter, or other small defects prior to laying the pipe.
- D. Supports and Anchors: All piping shall be firmly supported with fabricated or commercial hangers or supports in accordance with Section 15006 – Pipe Supports. Where necessary to avoid stress on equipment or structural members, the pipes shall be anchored or harnessed. Expansion joints and guides shall compensate for pipe expansion due to temperature differences. Supports shall be copper-plated steel to prevent galvanic corrosion.
- E. Valves and Unions: Unless otherwise indicated, piping to fixtures, groups of fixtures, and equipment shall be provided with a shutoff valve and union, unless the valve has flanged ends. Low points in water systems and driplegs in steam, gas, and air systems shall have drainage valves. Unions shall be provided at threaded valves, equipment, and other devices requiring occasional removal or disconnection.
- F. Branch Connections: Branch connections in horizontal runs of air and gas piping shall be made from the top of the pipe to avoid drainage of condensate into the equipment.
- G. Copper tubing for hot water shall be provided with silver brazing with insulation.

3.3 SOLDERING

- A. Solder Joints: All pipe and fittings to be jointed with solder shall be free from all burrs and wire brushed or steel wool cleaned. After cleaning, the flux shall be evenly and sparingly applied to the surfaces to be joined. Solder shall then be

applied and the flame passed toward the center of the fitting until the solder disappears. All excess solder shall be removed while it is still plastic. Absolutely no acid flux or acid wipe shall be used in making solder joints. Joints shall not be quenched after soldering.

- B. Solder used in copper piping shall be in accordance with ASTM B32, Grade 95 TA. Do not use cored solder.

3.4 PIPE JOINTS

- A. Threaded Joints: Pipe threads shall conform to ANSI/ASME B1.20.1 - Pipe Threads, General Purpose (inch), and shall be full and cleanly cut with sharp dies and friction tools. Not more than three threads shall remain exposed after installation.
- B. Brazed Joints: Brazed joints shall conform to the specifications and recommendations of ANSI/ASME B31.1 - Power Piping. All welding shall be done by skilled and qualified welders per Section 15000 – Piping, General.

3.5 INSPECTION AND FIELD TESTING

- A. Inspection: All finished installations shall be carefully inspected for proper supports, anchoring, interferences, and damage to pipe, fittings, and coating. Damage shall be repaired to the satisfaction of the Engineer.
- B. Field Testing: Prior to enclosure or burying, all piping systems shall be pressure tested as required in the Piping Schedule, for a period of not less than one hour, without exceeding the tolerances listed in the Piping Schedule. Where no pressures are indicated, the pipes shall be subject to 1-1/2 times the maximum working pressure. The Contractor shall furnish all test equipment, labor, materials, and devices at no extra cost to the Owner. For additional testing requirements, refer to Section 02640 – Pipeline Testing and Disinfection.
 - 1. Leakage may be determined by loss of pressure, soap solution, chemical indicator, or other positive and accurate method. All fixtures, devices, or other accessories which are to be connected to the lines and which would be damaged if subjected to the test pressure shall be disconnected and ends of the branch lines be plugged or capped as required during the testing procedures.
 - 2. Leaks shall be repaired to the satisfaction of the Engineer, and the system shall be retested until no leaks are found.

END OF SECTION

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SECTION 15060 – POLYVINYL CHLORIDE SOLVENT WELDED PIPE

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall furnish and install all exposed and buried solvent welded PVC piping and all appurtenant work, complete in place, including connection to existing and new structures, all in accordance with the requirements of the Contract Documents.
- B. All pipe specified under this Section shall conform to the requirements of Section 15000 – Piping, General.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. All work shall be performed in strict conformance with the industry standards, local laws, and ordinance specified in the General Requirements. Wherever the requirements of the specifications exceed those of these codes, the requirements of the specifications shall govern. Code compliance is mandatory. Nothing in these Contract Documents shall be construed as permitting work not in accordance with these laws and codes.

- B. Commercial Standards:

	ASTM D1784	Rigid PVC Compounds and Chlorinated PVC Compounds.
	ASTM D1785	Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
	ASTM F441	Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
	ASTM D2464	Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
Pipe	ASTM D2564	Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic and Fittings.
	ASTM D2774	Underground Installation of Thermoplastic Pressure Piping.
Fittings.	ASTM D3034	Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and
	ASTM D3139	Joints for Plastic Pressure Pipes using Flexible Elastomeric Seals.
	ASTM D3212	Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

ASTM F402	Safe Handling of Solvent Cements and Primers Used for Joining Thermoplastic Pipe and Fittings.
ASTM F477	Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
ASTM F656	Primers for Use in Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
ASTM F679	Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings
ASTM F913	Thermoplastic Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

1.3 CONTRACTOR SUBMITTALS

- A. For the materials and equipment items supplied under the provisions of this Section, the Contractor shall submit copies of the manufacturer's product specifications and performance details according to the requirements of Section 01330 Submittal Procedures, and the following supplemental requirements:
 1. List of Pipe Fittings to be used
 2. Manufacturer
 3. Model Number, if applicable
 4. Size and Schedule
 5. Material
 6. Pressure Rating
 7. Catalog Data
 8. Drawings
- B. Manufacturer's written Quality Assurance/Control Program.
- C. Certifications: The Contractor shall furnish a certified affidavit of compliance for all pipe and other products or materials furnished under this Section of the Specifications, as specified in the referenced standards.
- D. All expenses incurred in making samples for certification of tests shall be borne by the Contractor at no increased cost to the Owner.

1.4 QUALITY ASSURANCE

- A. Inspection: All pipe shall be subject to inspection at the place of manufacture in accordance with the requirements of the applicable referenced standards as supplemented by the requirements herein. The Contractor shall notify the Engineer in writing of the manufacturing starting date not less than 14 calendar days prior to the start of any phase of the pipe manufacture.
- B. During the manufacture of the pipe, the Engineer shall be given access to all areas where manufacturing is in process and shall be permitted to make all inspections necessary to confirm compliance with the Specifications
- C. Tests: Unless otherwise specified, all material used in the manufacture of the pipe shall be tested in accordance with the requirements of the applicable referenced standards.
- D. The Contractor shall perform all material tests at no additional costs to the Owner. The Engineer shall have the right to witness all testing conducted by the Contractor provided that the Contractor's schedule is not delayed for the convenience of the Engineer. In addition to those test specifically required; the Engineer may request additional samples of any material for testing by the Owner. The additional samples shall be furnished at no additional cost to the Owner.

PART 2 PRODUCTS

2.1 PVC (POLYVINYL CHLORIDE) PRESSURE PIPE, SOLVENT-WELDED

- A. PVC pipe shall be made from all new rigid unplasticized polyvinyl chloride and shall be Normal Impact Class 12454-B, Schedule 80, conforming to ASTM D1785, unless otherwise shown. Elbows and tees shall be of the same material as the pipe. Unless otherwise shown, joint design shall be for solvent-welded construction to the pipe manufacturer's specifications. Threaded joints shall be made with Teflon tape, only.
- B. Joints: shall be joined using solvent cement in accordance with ASTM D2564 and ASTM D1784. Primers for use on solvent cement joints shall be in accordance with ASTM F656, and handling of primers and solvent cements shall conform to ASTM F402. Solvent cements shall comply with requirements for potable water use. Threaded and flanged joints shall be used where required.

2.2 CPVC (CHLORINATED POLYVINYL CHLORIDE) PRESSURE PIPE, SOLVENT-WELDED

- A. CPVC pipe, for hot, corrosive solutions and where shown, shall be made from all new rigid unplasticized chlorinated polyvinyl chloride, Class 23447-B, and shall be Schedule 80 conforming to ASTM F441, with solvent-welded fittings of the same material as the pipe, unless otherwise shown. Joints shall be made to the pipe manufacturer's specifications. Threaded joints shall be made with Teflon tape, only.

2.3 THREADED LUBRICANT

- A. Threaded lubricant shall be Teflon tape. Lubricant, if required, shall be suitable for lubricating the parts of the joints in the assembly. The lubricant shall have no deteriorating effects on the gasket and pipe material.

2.4 SOLVENT CEMENT

- A. All connections to be joined by PVC (polyvinyl chloride) solvent cement shall be industrial grade and shall conform to ASTM D2564 and shall bear a dated stamp on the container indicating the date of manufacture. Manufacture and viscosity shall be as recommended by the pipe and fitting manufacturer to assure compatibility. Primers used in solvent cement connections shall be in accordance with ASTM F656 and handling of primers and solvent cements shall conform to ASTM F402.

2.5 FLANGES

- A. PVC flanges shall be supplied with all necessary gaskets, bolts, and nuts. Gaskets shall be full face, 1/16-inch thick Viton.

2.6 GASKETS AND BOLTS

- A. Except as otherwise provided, gaskets for flanged joints shall be in accordance with the requirements of Section 15000 – Piping, General.
- B. Except as otherwise provided, bolts shall conform to the requirements of Section 05500 – Metal Fabrications.

2.7 PIPE INSULATION

- A. Chemical piping shall be insulated as shown, in accordance with the requirements indicated.

2.8 PIPE SUPPORTS

- A. Pipe Supports, hangers, anchors, and guides shall be in accordance with the requirements of Section 15006 – Pipe Supports.

PART 3 EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

- A. All pipe shall be handled or packaged in such a manner as to provide adequate protection for the pipe and the pipe ends during transportation from manufacturer, and supplier, to the site.
- B. Pipe and fittings shall not be stored in direct sunlight. Pipe shall be stored in such a manner as to prevent sagging or bending. Pipe supports shall be properly and adequately supported and anchored so as to maintain the supported loads in proper position under all operating conditions without unnecessary movement or strain on any piece of equipment. Thrust blocks shall be provided where necessary to resist system pressure on fittings.

- C. PVC solvent cements shall be stored in a cool place, except when actually in use during the joining process.
- D. Any section of pipe that has been dented or damaged or in any other way found to be defective, either before or after placing, shall be replaced with sound pipe without additional expense to the Owner.

3.2 INSTALLATION

- A. All rigid polyvinyl chloride (PVC) pipe shall be cut square, burrs removed, made up, and installed in accordance with the pipe manufacturer's recommendations, as approved. Offset shall be as recommended by the manufacturer for the maximum temperature variation between time of solvent welding and final use.
- B. Pipe shall not be laid when the temperature is below 40 degrees F, nor above 90 degrees F when exposed to direct sunlight. Ends to be joined shall be shielded from direct sunlight prior to and during the laying operation.
- C. Provide adequate ventilation when working with pipe joint solvent cement.
- D. PVC and CPVC pipe joints shall be solvent-welded in accordance with the manufacturer's instructions. Expansion joints or pipe bends shall be provided to absorb pipe expansion over a temperature range of 100 degrees F, unless otherwise shown. Care shall be taken to provide sufficient supports, anchors, and guides, to avoid stress on the piping. The Contractor shall obtain the services of the pipe manufacturer, to instruct the pipe fitters in the correct way of making solvent welded and threaded joints. Only clean, fresh primer and solvent shall be used at all times at the recommended temperatures.
- E. The installation of plastic pipe valves; fittings and tubing shall be in strict accordance with the manufacturer's technical data and printed instructions, including the use of expansion joints and/or expansion loops, necessary for the piping to tolerate a 100 degree F change in operating temperature or any straight run of greater than 40 feet.
- F. All piping shall have a sufficient number of unions to allow convenient removal of piping and shall be as approved by the Engineer.
- G. Particular care should be taken to avoid overstressing or breaking of the pipe at the sleeves.
- H. Underground installation of PVC pipe, fittings and valves shall be as specified below and in ASTM D2774.
- I. Where plastic pipe passes through walls, wall penetrations shall be made as shown on the Drawings.
- J. All plastic pipe to metal pipe connections shall be made using flanged connections. Metal piping shall not be threaded into plastic fittings, valves, or couplings, nor shall plastic piping be threaded into metal valves, fittings or couplings.

- K. Where small piping is specified to be PVC (polyvinyl chloride) and is not specifically described herein, it shall be Schedule 80 with solvent weld joints as specified under above for water piping.

3.3 TESTING

- A. All lines shall be hydrostatically tested. Test procedures shall be as specified in Section 15000 – Piping, General and Section 02640 – Pipeline Testing and Disinfection.
- B. Prior to inspection and testing, stabilize piping by bringing it approximately to operating temperature before testing.
- C. Cure Period: A 24-hour cure period shall be required before the piping system is pressure tested.
- D. All leaks shall be repaired and all leaking lines retested as approved by the Engineer.

3.4 SUPPORTS AND HANGERS

- A. Pipe supports shall be as specified by manufacturer's recommendations and in accordance with Section 15006 – Pipe Supports.

3.5 DISINFECTION AND CLEANING

- A. All lines shall be cleaned, and all potable water lines shall be cleaned and disinfected, before being put in service, in accordance with Section 02640 – Pipeline Testing and Disinfection.

3.6 PAINTING

- A. All unburied polyvinyl chloride (PVC) piping shall be painted in accordance with Section 09960 – Protective Coatings.

END OF SECTION

SECTION 15180 – STRAINERS

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall provide pipe strainers where indicated, complete and operable, in accordance with the Contract Documents.
- B. All strainers shall be of ample size, with the perforations suitable for each individual service, and designed for easy cleaning and removal of the strainer basket.

1.2 CONTRACTOR SUBMITTALS

- A. General: CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished under this Section and in referenced Sections in accordance with the requirements of Section 01300 - Submittals.
- B. Shop Drawings and Samples: In addition to the requirements of Section 01300 – Submittals, Product Data and Samples. CONTRACTOR shall submit the following:
 - 1. Construction details, sizes, dimensions, weights, materials, control diagrams, electric motor data, and pressure ratings, in accordance with Section 11000 - Equipment General.
- C. O & M Manuals: The CONTRACTOR shall provide operations and maintenance data for all equipment furnished for the project in accordance with Section 01730 - Operation and Maintenance Data.
- D. Tools: Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the Work hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.
- E. Spare parts list: List of suggested spare parts to maintain the equipment in service for a period of 5 years.

1.3 QUALITY ASSURANCE

- A. Warranty: A written warranty shall be provided for the equipment specified in this section as required in Section – 01785 Warranties and Bonds.

PART 2 PRODUCTS

2.1 STRAINERS (METAL BODY)

- A. Equipment Requirements: Strainers shall be of the Y-pattern or basket type, with flush connections, bronze bodies, a bottom blow off connection, and screwed ends for sizes 3-inch and smaller, and flanged ends for sizes greater than 3-inch. They shall be designed for not less than 250 psi working pressure in sizes 3-inch and smaller, and 125 psi working pressure in sizes over 3-inch. Strainers shall be of the same size as the entering pipe and the screens shall have a free area of not less than three times the cross-sectional area of the pipe.
- B. Strainers shall have tapped and plugged blow off connections and all the required piping to route blow off flows to the nearest drain, as indicated in the contract documents.
- C. Screens: Unless otherwise indicated or required by the service fluid, the screens shall be of type 316 stainless steel construction, easily removable, with perforation size of 1/64 –inch diameter or closest mesh equivalent.
- D. Spare parts: One spare set of screens shall be provided.
- E. Manufacturers, or Equal:
 - 1. Flexicraft.
 - 2. Sterling.

2.2 STRAINERS (BOTTOM DUMP MODEL)

- A. Where indicated in the Drawings, strainer shall be the bottom dump type with flush connections, stainless steel body, a 2-inch drain connection at the bottom of the strainer which shall allow for flushing of the inside of the screening elements. The bottom drain connection shall connect to a 2-inch drain line with a 2-inch ball valve.
- B. Strainer shall have screwed ends for sizes 3-inch and smaller, and flanged ends for sizes greater than 3-inch. They shall be designed for not less than 250 psi working pressure in sizes 3-inch and smaller, and 125 psi working pressure in sizes over 3-inch. Strainer outlet piping shall be of the same size as the entering pipe and the screens shall have a free area of not less than three times the cross-sectional area of the pipe.
- C. If the outlet pipe is offset in the vertical direction from the entering pipe, the CONTRACTOR shall provide all the necessary elbows and fittings to route the outlet pipe back up to the same vertical plane as the entering pipe. Piping and fittings shall be of the same type as the entering pipe.
- D. Screens, spare parts, and manufacturers shall be as specified for the metal body strainers.

2.3 STRAINERS (PLASTIC BODY)

- A. Equipment Requirements: Strainers shall be of the Y-pattern type with removable screen, cap, and EPDM or Viton O-ring seal, and PVC body with screwed ends, rated for the following pressures at 70 degrees F. The O-ring seals shall be as follows, unless indicated otherwise; Viton shall be used for sodium hypochlorite and polymer; EPDM shall be used for sodium bisulfite; and Buna N (nitrile) shall be used for alum.
 - 1. 150 psi for sizes 1/2 to 1 inch
 - 2. 90 psi for sizes 1-1/2 to 2 inches
 - 3. 60 psi for sizes 3 to 4 inches
- B. Screen: The screens shall be of PVC, with a free area of twice the cross-sectional area of the pipe and 1/32-inch perforations.
- C. Manufacturers, or Equal:
 - 1. ASAHI/AMERICA
 - 2. Hayward Industrial Products, Inc.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. The requirements of Section 11000 – Equipment, General apply to this section.
- B. A complete set of manufacturer's instructions covering storage, installation, operation, lubrication, and maintenance shall be furnished to the OWNER no later than the date the equipment is shipped. Care during storage and procedures for installation, lubrication, and startup of the equipment and motors shall be in strict conformance with the manufacturer's instructions.
- C. The CONTRACTOR shall prepare and load all material and articles for shipment in a manner that protects the equipment and coatings from damage in transit, shall include a packing list, and shall be responsible for and make good any and all damage. During shipping the rotating elements shall be suitably supported or disassembled to protect bearings.
- D. Where necessary, heavy parts or machines shall be mounted on skids or shall be crated, and any articles or materials that might otherwise be lost shall be boxed or wired in bundles and plainly marked for identification. The gross weight shall be clearly marked on all boxes or skidded equipment packages exceeding 200 pounds. All parts exceeding 200 pounds gross weight shall be prepared for shipment so that slings for handling by a crane may be readily attached while the parts are on the car or transport truck. Boxed parts, where it is unsafe to attach slings to the box, shall be packed with slings attached to the part, the slings to project through the box or crate so that attachment to the hoisting equipment can be readily made.

- E. All accessories and spare parts shall be packed separately in containers plainly marked "ACCESSORIES ONLY" or "SPARE PARTS ONLY." All packing materials shall be fire retardant. A packing list, listing the contents of each container, shall be placed in a moisture proof envelope, and securely fastened to the outside of the container.
- F. All parts shall be properly lubricated and protected so that no damage or deterioration will occur even during a prolonged delay from the time of shipment until installation is completed and the equipment is ready for operation.
- G. Finished ferrous surfaces not painted shall be properly protected to prevent rust and corrosion.
- H. The finished surfaces of all exposed flanges shall be protected by strong wooden blind flanges.

3.2 INSTALLATION

- A. Automatic strainers shall be installed in accordance with the Manufacturer's printed recommendations and approved procedures submitted with the shop drawings and as indicated.
- B. Lubricants: The CONTRACTOR shall provide the necessary oil and grease for initial operation.
- C. Unless otherwise indicated, strainers shall be provided ahead of any control valves, regulators, steam, and condensate traps, and where shown, and shall be preceded by shut-off valves.

3.3 TESTING

- A. General: testing in accordance with Section 01756 Facility Start Up.
- B. Factory testing:
 - 1. The CONTRACTOR shall be responsible for all costs associated with inspection and testing of materials, products, or equipment at the place of manufacture, unless specified otherwise.
 - 2. The following tests shall be conducted on each indicated automatic strainer and test data shall be submitted:
 - a. Hydrostatic test as testing with the applicable piping system.

END OF SECTION

SECTION 15200 – VALVES, GENERAL

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall provide all valves, actuators, and appurtenances, complete and operable, in accordance with the Contract Documents.
- B. The provisions of this Section shall apply to all valves and valve actuators except where otherwise indicated. Valves and actuators in particular locations may require a combination of units, sensors, limit switches, and controls indicated in other Sections of the Specifications.
- C. Single Manufacturer: Where two or more valves of the same type or size are required, the valves shall be furnished by the same manufacturer. Valve and valve actuators shall be provided by the valve supplier.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

ASTM A48	Specification for Gray Iron Castings
ASTM A126	Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A216	Specification for Steel Castings, Carbon Suitable for Fusion Welding for High-Temperature Service
ASTM A351	Specification for Steel Castings, Austenitic, for High-Temperature Service
ASTM A395	Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures
ASTM A536	Specification for Ductile Iron Castings
ASTM A515	Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service
ASTM B62	Specification for Composition Bronze or Ounce Metal Castings
ASTM B584	Specification for Copper Alloy Sand Castings for General Applications.

1.3 CONTRACTOR SUBMITTALS

- A. General: Submittals shall be furnished in accordance with Section 01330- Submittal Procedures.
- B. Shop Drawings: Shop drawings shall contain the following information:

1. Valve name, size, Cv factor, pressure rating, identification number (if any), and Specification Section number.
2. Complete information on valve actuator, including sizing calculations, manufacturer, model number, limit switches, and mounting.
3. Cavitation limits for all control valves.
4. Assembly drawings showing part nomenclature, materials, dimensions, weights, and relationships of valve handles, hand wheels, position indicators, limit switches, integral control systems, needle valves, and control systems.
5. Complete wiring diagrams and control system schematics.
6. Valve Labeling: A schedule of valves to be labeled, indicating in each case the valve location and the proposed wording for the label.

C. Certifications:

1. Factory Test Data: Where indicated, signed, dated, and certified factory test data for each valve requiring certification shall be submitted before shipment of the valve. The data shall also include certification of quality and test results for factory-applied coatings.
2. Prior to shipment, the Contractor shall submit for all valves over 12 inches in size, certified, notarized copies of the hydrostatic factory tests, showing compliance with the applicable standards of AWWA, ANSI, and ASTM.
3. Manufacturer's certification of proper installation.
4. Contractor's certification of satisfactory field testing.

D. O & M Manuals: The CONTRACTOR shall provide operators and maintenance data for all equipment furnished for the project in accordance with Section 01730, Operation and Maintenance Data.

E. Spare Parts List: A Spare Parts List shall contain the required information for each valve assembly, where indicated.

1.4 QUALITY ASSURANCE

A. Valves, gates, and actuators are to be engineered and manufactured under a Manufacturer's written Quality Assurance program. The Quality Assurance program is to be in effect for at least (5) years, to include a written record for periodic internal and external audits to confirm compliance with such program.

1.5 WARRANTY

A. A written suppliers warranty shall be provided for the equipment specified in this section as required in Section 01785 Warranties and Bonds.

1.6 MANUFACTURER'S SERVICE REPRESENTATIVE

- A. As specified in each pump section, a manufacturer/supplier's representative shall be present at the job site for assistance during installation, equipment startup, testing, and training.

1.7 MANUFACTURER'S UNIT RESPONSIBILITY

- A. Unless otherwise indicated, a single manufacturer shall be made responsible for coordination of design, assembly, testing, and furnishing of each valve type; however, the Contractor shall be responsible to the Owner for compliance with the requirements of each valve section.

PART 2 PRODUCTS

2.1 GENERAL

- A. All valves and gates shall be new and of current manufacture. All shut-off valves 6-inches and larger shall have actuators with position indicators. Buried valves shall be provided with valve boxes and covers containing position indicators and valve extensions. Manual shut-off valves mounted higher than 7-feet above working level shall be provided with chain actuators

B. VALVE SCHEDULE

1. The valve schedule is located at the end of this specification.
2. Notes:
 - a. Valves included and specified with package systems are not included in this schedule. Refer to the individual package system specifications.
 - b. Valve schedule includes manual valves 4 Inches and above.
- 3.

2.2 VALVE COMPONENTS – GENERAL MATERIAL/PRODUCT

- A. General: All materials shall be suitable for the intended application. Materials not specified shall be high-grade standard commercial quality, free from all defects and imperfections that might affect the serviceability of the product for the purpose for which it is intended. Unless otherwise specified, valve and actuator bodies shall conform to the following requirements:
 1. Cast Iron: Close-grained gray cast iron, conforming to ASTM A48 - Specification for Gray Iron Castings, Class 30, or to ASTM A126 - Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 2. Ductile Iron: ASTM A536 - Specification for Ductile Iron Castings, or to ASTM A395 - Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
 3. Steel: ASTM A216 - Specification for Steel Castings, Carbon Suitable for Fusion Welding for High-Temperature Service, or to ASTM A515 -

Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service.

4. Bronze: ASTM B62 - Specification for Composition Bronze or Ounce Metal Castings, and valve stems not subject to dezincification shall conform to ASTM B584 - Specification for Copper Alloy Sand Castings for General Applications.
 5. Stainless Steel: Stainless steel valve and operator bodies and trim shall conform to ASTM A351 - Specification for Steel Castings, Austenitic, for High-Temperature Service, Grade CF8M, or shall be Type 316 stainless steel.
- B. Bodies: Valve bodies shall be cast, forged, or welded of the materials indicated, with smooth interior passages. Wall thicknesses shall be uniform in agreement with the applicable standards for each type of valve, without casting defects, pinholes, or other defects that could weaken the body. All welds on welded bodies shall be done by certified welders and shall be ground smooth. Valve ends shall be as indicated and be rated for the maximum temperature and pressure to which the valve will be subjected.
- C. Flanges: Valve flanges shall be in accordance with ANSI B16.1, B 16.5 and ASTM A126, unless otherwise indicated. For small diameter pipe, valve flanges shall be in accordance with industry standards. CONTRACTOR is responsible for coordinating pipe and valve flanges to ensure that they are compatible.
- D. Bonnets: Valve bonnets shall be clamped, screwed, or flanged to the body and shall be of the same material, temperature, and pressure rating as the body. The bonnets shall have provision for the stem seal with the necessary glands, packing nuts, or yokes.
- E. Valve Stems: Valve stems shall be of the materials indicated, or, if not indicated, of the best commercial material for the specific service, with adjustable stem packing, O-rings, Chevron V-type packing, or other suitable seal. Where subject to dezincification, bronze valve stems shall conform to ASTM B62, containing not more than 5 percent of zinc or more than 2 percent of aluminum, with a minimum tensile strength of 414 MPa (60,000 psi), a minimum yield strength of 276 MPa (40,000 psi), and an elongation of at least 10 percent in 50 mm (2 inches.) Where dezincification is not a problem, bronze conforming to ASTM B584 may be used.
- F. Internal Parts: Internal parts and valve trim shall be as indicated for each individual valve. Where not indicated, valve trim shall be of Type 316 stainless steel or other best suited material.
- G. Valve Operators: All valve operators, regardless of type, shall be manufactured, installed, adjusted, and tested by the valve manufacturer at the manufacturer plant. All valves shall open counter-clockwise unless otherwise shown or specified.
- H. Position Indicators: All shut-off valves 14-inch and larger, shall have operators with position indicators. Where buried, these valves shall be provided with valve boxes and covers containing extensions and position indicators.
- I. Valve Boxes and Covers: Valve box and cover shall be cast iron. Where valve boxes house position indicators, the valve box shall conform to the requirements of the

position indicator manufacturer. All covers shall be imprinted as shown on the Drawings.

- J. Valves shall be furnished complete with the accessories required to provide a functional system.
- K. Valve Actuators: Unless otherwise indicated, valve actuators shall be in accordance with Section 15201 – Valve and Gate Actuators for all electric motor-actuated valves. All valve and gate actuators on the project shall be of the same manufacturer.
- L. Valve labeling: Except when such requirement is waived by the Engineer in writing, a label shall be provided on all shut-off valves and control valves except for hose bibs. The label shall be of 1/16-inch plastic or stainless steel, minimum 2 inches by 4 inches in size, as indicated in Section 15005 - Piping Identification Systems, and shall be permanently attached to the valve or on the wall adjacent to the valve as directed by the Engineer.
- M. Valve Marking: All valve bodies shall be permanently marked in accordance with MSS SP25 - Standard Marking Systems for Valves, Fittings, Flanges, and Unions.

2.3 SPARE PARTS

- A. Where indicated, the Contractor shall furnish the required spare parts suitably packaged and labeled with the valve name, location, and identification number. The Contractor shall also furnish the name, address, and telephone number of the nearest distributor for the spare parts of each valve. All spare parts are intended for use by the Owner, only after expiration of the guarantee period.

2.4 PROTECTIVE COATING

- A. The exterior surfaces of all valves and the wet interior surfaces of all ferrous valves of sizes 4 inches and larger shall be coated in accordance with Section 09960 – Protective Coatings. The valve Manufacturer shall certify in writing that the required coating has been applied and tested in the manufacturing plant prior to shipment, in accordance with these Specifications. Flange faces of valves shall not be epoxy coated.
- B. Where surfaces have been shop painted but have been damaged during delivery, storage or assembly, or where shop coats have deteriorated, these surfaces shall be properly cleaned and retouched or repainted with matching paint.

2.5 BUTTERFLY VALVES - AWWA

- A. General: Butterfly valves for water working pressures up to 1,030 KPa (150 psi) shall conform to ANSI/AWWA C504, except for lay length and shaft diameters. Valves are subject to the following requirements. Valves shall be of the size and class indicated. Wafer valves shall be class 150B. The interior passage of butterfly valves shall not have any obstructions or stops. Valves 750 mm (30-inches) and larger shall have a wide diameter not smaller than 38 mm (1 ½ - inches) less than the normal valve size. The inside diameter shall be measured at the inside diameter of the seat or the smallest inside diameter location. Unless otherwise indicated, all valves shall open counter-clockwise.

B. Materials of Construction

1. Body: The valve body shall be constructed of ASTM A536 ductile iron or ASTM A126 Class B cast iron and shall be flanged type or lugged type. Flanged valves shall have ANSI 125-lb flanges.
2. Disc: The disc shall be of ductile iron, ASTM A536 Grade 65-45-12, Nylon 11 Coated or ASTM A126 Class B cast iron. The disc seating edge shall be solid Type 316 stainless steel. The disc shall be securely attached to the valve using Type 304 stainless steel taper pins.
3. Seat: Seats for valves smaller than 24" shall be bonded to the body or clamped to the disc edge. The disc-mounted seats shall be retained on the disc by means of an ASTM A167 or A240 Type 304 stainless steel ring and cap screws. The seats shall be positively clamped or bonded into the disc or body of the valve. The seat shall line the body of the valve and shall be food grade EPDM. Seats shall be field replaceable. The seat design of the 24" or larger valves shall allow for replacement and field adjustment of the full 360 degree circumference without dismantling the operator, disc, or shaft and without removing the valve from the pipeline.
4. Shaft: The shaft shall be of one-piece construction, of ASTM A276 or A240 Type 304 stainless steel. The shaft shall be provided with a machined groove or chamfer on the top end of the shaft, indicating the precise disc position on the shaft. Shaft diameters shall be in compliance with AWWA C504.
5. Bearings: Bearings shall be per AWWA C504 requirements. Bearings shall be Teflon lined with non-metallic fiberglass composite backing and shall be permanently lubricated.
6. Shaft Seals: Shaft seals shall be designed for use with standard split-V type packing with a minimum of four sealing rings.
7. Actuator: Unless otherwise indicated, the valve actuators shall be of the worm gear type or traveling nut type, in accordance with Section 15201 - Valve and Gate Actuators, designed for the full bi-directional rating of the valve.
8. Manual Actuators: Actuators shall conform to ANSI/AWWA C540, subject to the following requirements. Unless otherwise indicated, all manually-actuated butterfly valves shall be equipped with a hand wheel or chain operator as shown or indicated. All buried valves shall be equipped with a 2-inch square actuating nut and ground-level position indicator. Screw-type (traveling nut) actuators will not be permitted for valves 30 inches in diameter and larger. Manual actuators shall allow for positive throttling and locking in any position from open to closed.
9. Worm Gear Actuators: All submerged and buried valves shall be equipped with worm-gear or traveling nut type actuators, lubricated and sealed to prevent entry of dirt or water into the housing.

10.

- C. Protective coating: Interior and exterior valve surfaces shall be coated in accordance with Section 09960 – Protective Coatings.
- D. Manufacturers, or Equal:
 - 1. De Zurik Corporation
 - 2. Henry Pratt Company
 - 3. M & H Valve Company
 - 4. Mueller Company

2.6 METAL BALL VALVES (4-INCH AND SMALLER)

- A. General: Unless otherwise indicated, general purpose metal ball valves in sizes up to 4-inch shall have actuators in accordance with Section 15201 - Valve and Gate Actuators.
- B. Materials of Construction
 - 1. Body: All metal ball valves up to 1-1/2-inch (incl.) in size shall have bronze or carbon steel 2-or 3-piece bodies with screwed ends for a pressure rating of not less than 600 psi WOG. Valves 2-inch to 4-inch in size shall have bronze or carbon steel 2-or 3-piece bodies with flanged ends for a pressure rating of ANSI 125 psi or 150 psi, unless otherwise indicated.
 - 2. Balls: The balls shall be solid chrome plated brass or bronze, or stainless steel, with standard port (single reduction) or full port openings.
 - 3. Stems: The valve stems shall be of the blow-out proof design, of bronze, stainless steel, or other acceptable construction, with reinforced Teflon seal.
 - 4. Seats: The valve seats shall be of Teflon or Buna-N, for bi-directional service and easy replacement.
- C. Manufacturers, or Equal:
 - 1. Conbraco Industries, Inc. (Apollo).
 - 2. ITT Engineered Valves.
 - 3. Neles-Jamesbury, Inc.
 - 4. NIBCO, Inc.
 - 5. Watts Regulator

6. Worcester Controls

2.7 PLASTIC BALL VALVES

- A. General: Plastic ball valves for corrosive fluids shall be made of polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC), or polyvinylidene fluoride (PVDF), as recommended by the Manufacturer for the specific application. All valves shall have manual actuators in accordance with Section 15201 - Valve and Gate Actuators, unless otherwise indicated. The valves shall be suitable for a maximum working non-shock pressure of 150 psi at 73 degrees F for PVC, with decreasing ratings for higher temperatures and other plastics.
- B. Materials of Construction
 - 1. Body: All plastic ball valves shall have union ends or flanged ends to mate with ANSI B16.5, class 150, for easy removal.
 - 2. Balls: The balls shall have full size ports and Teflon seats. All body seals, union O-ring seals, and stem seals shall be corrosion resistant for the fluid and field application.
- C. Manufacturers, or Equal:
 - 1. ASAHl-America.
 - 2. George Fischer, Inc.
 - 3. NIBCO Inc., (Chemtrol)
 - 4. Watts Regulator

2.8 PLASTIC BODY DIAPHRAGM VALVES

- A. Materials of Construction: Unless otherwise indicated, valve bodies shall be of PVC, CPVC, PP, or PVDF construction, as best-suited for each individual service, with union ends, screwed ends, socket-welded ends, or flanged ends to ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings, drilled to 150 lb. dimensions, as indicated. The valve bonnets shall be flanged and of PVC, PP, or PVDF construction. The valve stem shall be of carbon steel or stainless steel with brass, bronze, or cast-iron sleeve and a compressor of aluminum, brass, bronze, or cast-iron. The bolts, nuts, and washers shall be of stainless steel and the stem and bonnet seals of Viton or Buna-N O-rings. Valves in sizes 1/2-inch through 4-inch shall have a pressure rating of 150 psi at 104 degrees F, diminishing to not less than 50 psi for larger sizes.
- B. Diaphragm: The diaphragms of all valves shall be of the best-suitable material for any given service. Unless otherwise recommended by the manufacturer, the diaphragm material shall be chlorosulfonated polyethylene such as Hypalon or equal, except that the diaphragms for valves in chlorine solution and chlorine gas lines shall be Teflon. All diaphragms shall be of rugged, reinforced construction, be oil resistant, and be designed for long life.

C. Manufacturers, or Equal:

1. ASAHI/America
2. George Fischer, Inc. (+GF+)
3. ITT Dia-Flo (Grinnell)
4. Mc Canna, Inc.

2.9 METAL-SEATED GATE VALVES (3-INCH AND LARGER)

- A. General: Metal-seated gate valves for water and sewage service shall conform to ANSI/AWWA C500 - Metal-Seated Gate Valves for Water Supply Service. The design working water pressure shall be 200 psig for valves 12 inches and smaller and 150 psig for larger valves. The valves may be of the double-disc type for tighter shut-off, or of the solid-wedge type, with rising or non-rising stem. For sewage or fluids containing solids, an outside thread shall be used.
- B. Materials of Construction: The valve bodies shall be of cast iron conforming to ASTM A126 - Specifications for Gray Iron Castings for Valves, Flanges, and Pipe Fittings, or ductile iron conforming either to ASTM A395 - Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures, or to ASTM A536 - Specification for Ductile Iron Castings, with flanged, bell and spigot, or mechanical joint-ends as indicated. Body and bonnett wall thickness shall be equal to or greater than the minimum wall thickness as listed in Table 2 of ANSI/AWWA C500. Valves 14-inch and larger installed in vertical pipes shall be fitted with bronze slides, tracks, rollers, and scrapers to assist the travel of the gate assembly. Gate valves 14-inch and larger shall be furnished with bypass assemblies.
- C. Actuators: Unless otherwise indicated, all gate valves shall have manual actuators in accordance with Section 15201 - Valve and Gate Actuators.
- D. Protective coating: Interior and exterior valve surfaces shall be coated in accordance with Section 09960 - Protective Coatings.
- E. Manufacturers, or Equal:
1. American Flow Control
 2. Clow Valve Co.
 3. Crane Valves
 4. Kennedy Valve
 5. M & H Valve Company
 6. Milwaukee Valve Company, Inc.
 7. Mueller Company (Grinnell Corp.)
 8. Stockham Valves and Fittings

2.10 RESILIENT-SEATED GATE VALVES (3- TO 16-INCH)

- A. General: Resilient-seated gate valves may be provided in lieu of metal-seated double-disc or solid-disc gate valves, at the discretion of the Engineer.
- B. Materials of Construction: Resilient-seated gate valves shall conform to ANSI/AWWA C509 - Resilient-Seated Gate Valves for Water and Sewerage Systems. The valves shall be suitable for a design working water pressure of 200 psig, with flanged, bell and spigot, or mechanical joint ends. The valve body, bonnet, and disc shall be of cast iron or ductile iron and the disc or body shall be rubber-coated. Body and bonnet wall thickness shall be equal to or greater than the minimum wall thickness as listed in Table 2 of ANSI/AWWA C509. The stem, stem nuts, glands, and bushings shall be of bronze, with the stem seal per ANSI/AWWA C509.
- C. Actuators: Unless otherwise indicated, resilient-seated gate valves shall have manual actuators in accordance with Section 15201 - Valve and Gate Actuators.
- D. Protective coating: Interior and exterior valve surfaces shall be coated in accordance with Section 09960 – Protective Coatings.
- E. Manufacturers, or Equal:
 - 1. American Flow Control
 - 2. Clow Valve Co.
 - 3. Kennedy Valve
 - 4. M & H Valve Company
 - 5. Mueller Company (Grinnell Corp.)
 - 6. Stockham Valves and Fittings

2.11 GATE VALVES (SMALLER THAN 3-INCH)

- A. General: Gate valves, smaller than 3-inch, for general purpose use, shall be non-rising stem, heavy-duty type for industrial service, with screwed or soldered ends to match the piping. All valves shall have a pressure rating of minimum 125 psi steam, and 200 psi coldwater, unless otherwise indicated.
- B. Materials of Construction
 - 1. Body: The bodies shall have union bonnets of bronze conforming to ASTM B62 - Specification for Composition Bronze or Ounce Metal Castings.
 - 2. Stems: The stems shall be of bronze conforming to ASTM B62, or ASTM B371 - Specification for Copper-Zinc-Silicon Alloy Rod. The solid wedges shall be of bronze conforming to ASTM B62.

3. Handwheels and stem seals: The valves shall have malleable iron handwheels, unless otherwise indicated, and stem seals shall be of Teflon-impregnated or other acceptable non-asbestos packing.
- C. Protective coating: Interior and exterior valve surfaces shall be coated in accordance with Section 09960 - Protective Coatings.
- D. Manufacturers, or Equal:
 1. Crane Company
 2. Milwaukee Valve Company
 3. Wm. Powell Company
 4. Stockham Valves and Fittings
 5. Walworth Company

2.12 PLASTIC GATE VALVES (1-1/2- TO 14-INCH)

- A. Construction: Plastic gate valves shall have PVC bodies with ANSI 150 lb. flanged ends, and polypropylene or CPVC-SBR-lined plugs for tight shut-off. The non-rising stem shall be of PVC or Type 304 stainless steel construction, with O-ring seal. The valves shall have a coldwater pressure rating of 150 psig for sizes 1-1/2- through 8-inch, 110 psig for size 10-inch, and 70 psig for sizes 12- and 14-inch.
- B. Actuators: Unless otherwise indicated, PVC gate valves shall have manual handwheel actuators with position indicators, in accordance with Section 15201 - Valve and Gate Actuators.
- C. Manufacturers, or Equal:
 1. ASAHI/America

2.13 ECCENTRIC PLUG VALVES (1/2-INCH TO 72-INCH)

- A. General: Eccentric plug valves shall be of a non-lubricated, eccentric plug design.
- B. Performance: Unless otherwise indicated, all eccentric plug valves shall have a pressure rating of not less than 150 psi WOG, for bubble-tight shut-off in the standard flow direction, and 25 psi WOG in the reverse flow direction. When equipped with worm gear actuator, the pressure rating shall be 150 psi WOG in both directions. The stem seal shall consist of field adjustable packing, replaceable without removal of the actuator, or of self-adjusting U-cup packing.
- C. Materials of Construction
 1. Body: Valve body shall be cast iron conforming to ASTM A126 - Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings with ANSI 125 lb. flanged ends for valves 3-inch and larger, and screwed or flanged ends for smaller sizes.

2. Plugs and Shafts: The plugs and shafts shall be of solid cast iron or ductile iron conforming to ASTM A536-Specification for Ductile Iron Castings, and the plugs shall be lined with a resilient coating, best suited for the specific service.
3. Seats: The seats shall be of nickel or stainless steel welded to the body. Eccentric plug valves for digester gas service shall have Type 316 stainless steel plugs and suitable resilient seating of Viton.
4. Stem Seal: Shall be of a self-adjusting elastomer U-cup design. The stem seal elastomer shall be the same as the plug elastomer. O-rings are not acceptable.
5. Bearings: All top and bottom shaft bearings shall be of permanently lubricated stainless steel, or Teflon coated stainless steel. Grit seals of Teflon, Nylatron, or similar suitable material shall be at the top and bottom plug journals O-ring style grit seals are unacceptable.
6. Port Flow Way: 2-1/2" to 12", the flow way shall be round, 100 percent area, full port design. Valves greater than 12", the flow way shall be round or rectangular, 100 percent area full port design. Flow coefficients for 2-1/2" valves to 36" shall comply with the following table:

7.	8. 21 /2"	9. 3"	10. "	11. "	12. "	13. "	14. 0"	15. 2"
16. Mini mum Cv	17. 60	18. 35	19. 120	20. 000	21. 359	22. 182	23. 073	24. 366
25.	26.	27.	28.	29.	30.	31.	32.	33.
34.	35. 4"	36. 6"	37. 8"	38. 0"	39. 4"	40. 0"	41. 6"	42.
43. Mini mum Cv	44. ,505	45. ,365	46. 1,196	47. 6,131	48. 1,343	49. 6,445	50. 7,871	51.

- D. Actuators: Unless otherwise indicated, all eccentric plug valves 3-inch and smaller shall have operating levers; all larger valves shall have worm-gear actuators. Valve actuators shall be in accordance with Section 15201 - Valve and Gate Actuators.
- E. Protective coating: The body shall be lined with a suitable elastomer, where required for a special service, or it shall be epoxy-lined in accordance e with Section 09960 – Protective Coatings.
- F. Manufacturers, or Equal:
 1. Milliken
 2. DeZurik Corporation

3. Val Matic - Cam Centric

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. The Contractor shall prepare and load all material and articles for shipment in a manner that protects the equipment and coatings from damage in transit, shall include a packing list, and shall be responsible for and make good on any and all damage.
- B. All accessories and spare parts shall be packed separately in containers plainly marked "ACCESSORIES ONLY" or "SPARE PARTS ONLY." All packing materials shall be fire retardant. A packing list, listing the contents of each container, shall be placed in a moisture proof envelope and securely fastened to the outside of the container.

3.2 INSTALLATION

- A. General: All valves, actuating units, stem extensions, valve boxes, and accessories shall be installed in accordance with the Manufacturer's written instructions and as indicated. All gates shall be adequately braced to prevent warpage and bending under the intended use. Valves shall be firmly supported to avoid undue stresses on the pipe. Where applicable, valves shall be installed with the seat upstream.
- B. Access: All valves shall be installed with easy access for actuation, removal, and maintenance and to avoid interference between valve actuators and structural members, handrails, or other equipment.
- C. Valve Accessories: Where combinations of valves, sensors, switches, and controls are indicated, the Contractor shall properly assemble and install such items so that all systems are compatible and operating properly. The relationship between interrelated items shall be clearly noted on shop drawing submittals.

3.3 TESTING

- A. General: All valve testing shall be in accordance with applicable standards of AWWA, ANSI, and ASTM.
- B. Factory Testing: As a minimum, unless otherwise indicated, each valve body 4 inches and larger shall be tested hydrostatically to 1.5 times its rated 100 degrees F design water-working pressure, for a period of 5 minutes, without showing any leaks or loss of pressure. In addition, each valve 4 inches and larger shall undergo a functional test to demonstrate satisfactory operation throughout its operating cycle, and a closure test at rated 100 degrees F water-working pressure for a period of 5 minutes to demonstrate tight shut-off. Stem seal leakage shall not be a cause for rejection. All valves 3 inches and smaller shall undergo the Manufacturer's standard test.
- C. Performance Testing: All valves shall be tested with the piping system in accordance with Section 02640 – Pipeline Testing and Disinfection. Field testing will be witnessed by the Engineer. The Contractor shall furnish three days advance notice of field testing.

3.4 SUPPLEMENTS

- A. The supplements listed below, following "END OF SECTION", are part of this Specification.

1. Valve Schedule

END OF SECTION

Valve Schedule

LOCATION	VALVE NO.	DESCRIPTION	VALVE TYPE	ACTUATOR TYPE	SIZE (IN)	NOTES
Primary Sludge Pumping (North)	PC1-PMP1-PVLV04-01	Primary Sludge Pump 1 Suction Plug Valve	Plug valve	Motor	4	Full Port
Primary Sludge Pumping (North)	PC1-PMP1-PVLV04-02	Primary Sludge Pump 1 Discharge Plug Valve	Plug valve	Manual	4	Full Port
Primary Sludge Pumping (North)	PC1-PMP1-PVLV04-03	Primary Sludge Pump 1 Blind Flange Isolation Plug Valve	Plug valve	Manual	4	Full Port
Primary Sludge Pumping (North)	PC1-PMP1-PVLV04-04	Primary Sludge Pump 1 Inspection Box Isolation Plug Valve	Plug valve	Manual	4	Full Port
Primary Sludge Pumping (North)	PC1-PMP1-PVLV04-05	Primary Sludge Pump 1 Downstream Meter Isolation Plug Valve	Plug valve	Manual	4	Full Port
Primary Sludge Pumping (South)	PC1-PMP2-PVLV04-01	Primary Sludge Pump 2 Suction Plug Valve	Plug valve	Motor	4	Full Port
Primary Sludge Pumping (South)	PC1-PMP2-PVLV04-02	Primary Sludge Pump 2 Discharge Plug Valve	Plug valve	Manual	4	Full Port
Primary Sludge Pumping (South)	PC1-PMP2-PVLV04-03	Primary Sludge Pump 2 Blind Flange Isolation Plug Valve	Plug valve	Manual	4	Full Port
Primary Sludge Pumping (South)	PC1-PMP2-PVLV04-04	Primary Sludge Pump 2 Downstream Isolation Plug Valve	Plug valve	Manual	4	Full Port
Primary Sludge Pumping (South)	PC1-PMP2-PVLV04-05	Primary Sludge Pump 2 Upstream Isolation Plug Valve	Plug valve	Manual	4	Full Port
Digested Sludge Transfer Pumping	DG1-PMP1-PVLV04-01	Digested Sludge Transfer Pump 1 Suction Plug Valve	Plug valve	Motor	4	Full Port
Digested Sludge Transfer Pumping	DG1-PMP1-PVLV04-02	Digested Sludge Transfer Pump 1 Discharge Plug Valve	Plug valve	Manual	4	Full Port
Digested Sludge Transfer Pumping	DG1-PMP1-PVLV04-03	Digested Sludge Transfer Pump 1 Downstream Isolation Plug Valve	Plug valve	Manual	4	Full Port
Digested Sludge Transfer Pumping	PC1-PMP1-CVLV04-01	Primary Sludge Pump 1 Discharge Check Valve	Check valve	N/A	4	

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SECTION 15201 – VALVE AND GATE ACTUATORS

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall provide all valve and gate actuators and appurtenances, complete and operable, in accordance with the Contract Documents.
- B. The provisions of this Section shall apply to all valves and gates, except where otherwise indicated in the Contract Documents.
- C. Single Manufacturer: Where two or more valve or gate actuators of the same type or size are required, the actuators shall all be produced by the same manufacturer.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

ANSI/AWWA C540	AWWA Standard for Power-Actuating Devices for Valves and Sluice Gates AWWA
AWWA C500	Metal-Seated Gate Valves for Water Supply Service

1.3 CONTRACTOR SUBMITTALS

- A. General: Submittals shall be furnished in accordance with Section 01330 – Submittal Procedures, and Section 15200 - Valves, General.
- B. Shop Drawings: Shop Drawings of all actuators shall be submitted together with the valve and gate submittals as a complete package in accordance with Section 15200 - Valves, General. Complete wiring diagrams shall be provided for electric actuators.
- C. Certifications: Manufacturer's certificate of compliance that equipment furnished meet requirements of this specification.
- D. O & M manuals: O&M manuals shall be submitted in accordance with Section 15200 - Valves, General.
- E. Electrical and Control Submittals
 - 1. Provide complete information on control stations and valve actuators. Provide a bill of materials including tag numbers.
 - 2. Include complete information on electric power and interconnection requirements.
 - 3. Provide complete information on signal inputs and outputs: discrete (contact closures), and analog (4-20 milliamp signals).
 - 4. Electrical drawings and data shall be complete, shall represent the

equipment proposed for this project, and shall meet the applicable requirements of Section 16000 - Requirements for Electrical Work, and Section 13400 - Instrumentation and Controls. Drawings and data shall be adequate to demonstrate that the equipment meets the requirements of the Contract Drawings and Specifications, and also to be used by the Owner for operation, maintenance, and troubleshooting.

5. Provide electrical schematic diagrams and wiring diagrams as described in Section 16000 - Requirements for Electrical Work. They shall include interface wiring between actuators and control stations and other items on this project. Electrical schematic diagrams shall show circuits and device elements in ladder-diagram form without regard to physical location. Wiring diagrams shall show the connections and physical relationship of electrical devices and apparatus in circuits or groups of circuits within each actuator or control station.
6. For electrical schematic and wiring diagrams, manufacturer's standard drawings may be used, provided that they show the information required and are annotated to reflect the configuration for this project. For example, equipment numbers and descriptions unique to this project should be used, options not included should be stricken, signal interfaces with systems external to the actuators and control stations should be marked up to depict the actual interfaces on this project. Information and detail should be added to meet the requirements above, and other standard and optional provisions should be annotated to match this project.
7. Electrical drawings and data shall be identified with the device tag number and/or equipment number as shown on the Contract Documents, or otherwise shown.
8. Field Wiring Interconnection Diagram:
 - a. As described in Section 16000 - Requirements for Electrical Work, participate in the development of field wiring interconnection diagram(s). Provide detailed information showing termination provisions.

1.4 QUALITY ASSURANCE

- A. Pneumatic, hydraulic, or electric actuators are to be engineered and manufactured under a Manufacturer's written Quality Assurance program. The Quality Assurance program is to be in effect for at least (5) years, to include a written record for periodic internal and external audits to confirm compliance with such program.

1.5 MANUFACTURER'S SERVICE REPRESENTATIVE

- A. Field Adjustments:

1. Field representatives of manufacturers of valves or gates with pneumatic, hydraulic, or electric actuators shall adjust actuator controls and limit-switches in the field for the required function.
2. A Manufacturer's representative for electric operators shall be present at the job site for a minimum of two man days, travel time excluded, for assistance during installation, equipment startup, testing, and training.

1.6 MANUFACTURER'S UNIT RESPONSIBILITY

- A. Where applicable, the Valve Manufacturer shall be responsible for furnishing the electric valve actuators. To the extent practical, valve actuators for the entire project shall be furnished by a single Actuator Manufacturer. The Valve Manufacturer shall coordinate with the Contractor to furnish actuators by the selected Actuator Manufacturer. Where the single Actuator Manufacturer's equipment is not compatible with a Valve Manufacturer's equipment, the Valve Manufacturer may use an alternative actuator upon approval by the Engineer. Valve operation shall not be compromised due to valve and/or actuator compatibility. The Valve Manufacturer is responsible for providing a properly operating valve system.
- B. The Contractor shall coordinate with all valve and gate manufacturers to ensure that all electric operators supplied are of the same manufacturer. The intent is to receive the same make and Manufacturer for all motor operators, all valves of a specific type, and all gates.

PART 2 PRODUCTS

2.1 GENERAL

- A. General: Unless otherwise indicated, all shut-off and throttling valves, and externally-actuated valves and gates, shall be provided with manual or power actuators. The Contractor shall furnish all actuators complete and operable with mounting hardware, motors, gears, controls, wiring, solenoids, handwheels, levers, chains, and extensions, as applicable. All actuators shall be capable of holding the valve in any intermediate position between fully-open and fully-closed without creeping or fluttering. All wires of motor-driven actuators shall be identified by unique numbers.
- B. Materials: All actuators shall be current models of the best commercial quality materials and liberally-sized for the maximum expected torque. All materials shall be suitable for the environment in which the valve or gate is to be installed.
- C. Mounting: All actuators shall be securely mounted by means of brackets or hardware specially designed and sized for this purpose and of ample strength. The word "open" shall be cast on each valve or actuator with an arrow indicating the direction to open in the counter-clockwise direction. All gear and power actuators shall be equipped with position indicators. Where possible, manual actuators shall be located between 48 and 60 inches above the floor or the permanent working platform.

- D. Standard: Unless otherwise indicated and where applicable, all actuators shall be in accordance with ANSI/AWWA C540 - AWWA Standard for Power-Actuating Devices for Valves and Sluice Gates.
- E. Functionality: Electric, pneumatic, and hydraulic actuators shall be coordinated with power and instrumentation equipment indicated elsewhere in the Contract Documents.

2.2 MANUAL ACTUATORS

- A. General: Unless otherwise indicated, all valves and gates shall be furnished with manual actuators. Valves in sizes up to and including 4 inches shall have direct acting lever or handwheel actuators of the manufacturer's best standard design. Larger valves and gates shall have gear-assisted manual actuators, with an operating pull of maximum 60 pounds on the rim of the handwheel. All buried and submerged gear-assisted valves, all gates, all gear-assisted valves for pressures higher than 250 psi, all valves 30 inches in diameter and larger, and where so indicated, shall have worm-gear actuators, hermetically-sealed and grease-packed, where buried or submerged. All other valves 6 inches to 24 inches in diameter may have traveling-nut actuators, worm-gear actuators, spur- or bevel-gear actuators, as appropriate for each valve.
- B. Buried Valves: Unless otherwise indicated, all buried valves shall have extension stems to grade, with square nuts or floor stands, position indicators, and cast-iron or steel pipe extensions with valve boxes, covers, and operating keys. Where so indicated, buried valves shall be in cast-iron, concrete, or similar valve boxes with covers of ample size to allow operation of the valve actuators. Covers of valve boxes shall be permanently labeled as requested by the local Utility Company or the Engineer. Wrench-nuts shall comply with AWWA C500 - Metal - Seated Gate Valves for Water Supply Service, and a minimum of 2 operating keys, or one key per 10 valves, whichever is greater, shall be furnished. All buried valves shall have an operator shaft extension from the valve or valve operator to 6 inches below finished grade.
- C. Chain Actuator: Manually-activated valves with the stem located more than 7 feet above the floor or operating level shall be furnished with chain drives consisting of sprocket-rim chain wheels, chain guides, and operating chains, and be provided by the valve manufacturer. The wheel and guide shall be of ductile-iron, cast-iron, or steel, and the chain shall be hot-dip galvanized steel or stainless steel, extending to 5 feet 6 inches above the operating floor level. The valve stem of chain-actuated valves shall be extra strong to allow for the extra weight and chain pull. Hooks shall be provided for chain storage where chains interfere with pedestrian traffic.
- D. Floor Boxes: Hot-dip galvanized cast-iron or steel floor boxes and covers to fit the slab thickness shall be provided for all operating nuts in or below concrete slabs. For operating nuts in the concrete slab, the cover shall be bronze-bushed.
- E. Manual Worm-Gear Actuator: The actuator shall consist of a single or double reduction gear unit contained in a weather-proof cast-iron or steel body with cover and minimum 12-inch diameter handwheel. The actuator shall be capable of 90-degree rotation and shall be equipped with travel stops capable of limiting the valve

opening and closing. The actuator shall consist of spur or helical gears and worm-gearing. The spur or helical gears shall be of hardened alloy steel and the worm-gear shall be alloy bronze. The worm-gear shaft and the handwheel shaft shall be of 17-4 PH or similar stainless steel. All gearing shall be accurately cut with hobbing machines. Ball or roller bearings shall be used throughout. Actuator output gear changes shall be mechanically possible by simply changing the exposed or helical gearset ratio without further disassembly of the actuator. All gearing shall be designed for a 100 percent overload.

2.3 ELECTRIC MOTOR ACTUATORS

A. General:

1. Equipment Requirements: Where electric motor actuators are indicated, an electric motor-actuated valve control unit shall be attached to the actuating mechanism housing by means of a flanged motor adaptor piece.
2. Nameplate: A motor nameplate shall be provided stating model number, maximum torque, horsepower rating, voltage, amperage, service factor, etc.
3. Gearing: The motor actuator shall include the motor, reduction gearing, reversing starter, torque switches, and limit switches in a weather-proof NEMA 4, 4X, 6, or IP 68 assembly as specified. The actuator shall be a single or double reduction unit consisting of spur or helical gears and worm-gearing. The spur or helical gears shall be of hardened alloy steel and the worm-gear shall be alloy bronze. All gearing shall be accurately cut with hobbing machines. All power gearing shall be grease- or oil-lubricated in a sealed housing. Ball or roller bearings shall be used throughout. Actuator output speed changes shall be mechanically possible by simply removing the motor without further disassembly of the electric actuator.
4. Starting Device: Except for modulating valves, the unit shall be so designed that a hammer blow is imparted to the stem nut when opening a closed valve or closing an open valve. The device should allow free movement at the stem nut before imparting the hammer blow. The actuator motor must attain full speed before stem load is encountered.
5. Switches and Wiring: Travel in the opening and closing directions shall be governed by a switch responsive to mechanical torque developed in seating the valve, or by an obstruction met in opening or closing the valve, or by an on-board microprocessor. The torque switch shall be adjustable and shall function without auxiliary relays or devices, or it shall be adjustable in one-percent increments, sensed by an encoder that directly senses torque in the actuators gear drive. The geared limit switches shall be of the open type and shall be actuated by a rotor cam with 4 contacts to each cam or gear train. The actuator shall have a number of gear trains as required to produce the operation indicated. The actuator shall be wired in accordance with the schematic diagram. All wiring for external connections shall be connected to marked terminals. One 1-inch and one 1-1/4-inch conduit connection shall be provided in the enclosing case. A calibration tag shall be mounted near each switch correlating the dial setting to the unit output torque. Position limit

switches and associated gearing shall be an integral part of the valve actuator. To provide the best possible accuracy and repeatability, limit-switch gearing shall be of the "counting" intermittent type, made of bronze or stainless steel, grease-lubricated, and enclosed in its own gearcase to prevent dirt and foreign matter from entering the gear train. Switches shall not be subject to breakage or slippage due to over-travel. Limit-switches shall be rated 5 amps at 120 VAC.

6. Handwheel Operation: A permanently-attached handwheel shall be provided for emergency manual operation. The handwheel shall not rotate during electrical operation. The maximum torque required on the handwheel under the most adverse conditions shall not exceed 60 lb-ft, and the maximum force required on the rim of the handwheel shall not exceed 60 lb. An arrow and either the word "open" or "close" shall be cast or permanently affixed on the handwheel to indicate the appropriate direction to turn the handwheel.
7. Motor: The motor shall be of the totally-enclosed, non-ventilated, high-starting torque, low-starting current type for full voltage starting. It shall be suitable for operation on 480-volts, 3-phase or 120-volt, 1-phase as specified, 60-Hz current, and have Class F insulation and a motor frame with all dimensions in accordance with the latest revised NEMA MG Standards. The motor shall be suitable for submersible operation as specified. The observed temperature rise by thermometer shall not exceed 55 degrees C above an ambient temperature of 40 degrees C when operating continuously for 15 minutes under full rated load. With a line voltage ranging between 10 percent above to 10 percent below the rated voltage, the motor shall develop full rated torque continuously for 15 minutes without causing the thermal contact protective devices imbedded in the motor windings to trip or the starter overloads to drop-out. All bearings shall be of the ball type and thrust bearings shall be provided where necessary. All bearings shall be provided with suitable seals to confine the lubricant and prevent the entrance of dirt and dust. Motor conduit connections shall be watertight. Motor construction shall incorporate the use of stator and rotor as independent components from the valve operation such that the failure of either item shall not require actuator disassembly or gearing replacement. The motor shall be furnished with a space heater suitable for operation on 120-volt, single-phase, 60-Hz circuit unless the entire actuator is a hermetically-sealed, non-breathing design with a separately sealed terminal compartment that prevents moisture intrusion.
8. Control Station: Each electric operator shall be provided with a control station containing three momentary pushbuttons labeled Open, Stop, and Close, and three indicating ultra bright LED lights labeled Open /Closed and fault. A Local/Remote selector shall be provided on the control station. The control station shall provide local control and indication and shall receive Open, Stop, and Close commands from a remote location. Control stations may be required to be provided as wall mounted separate from the operator if operator control station is inaccessible by operations staff due to height, location, or orientation. Otherwise, they shall be integrally mounted on the motor operator. Control stations shall be NEMA 4, 4X, or 6 where specified. Where indicated, control stations shall be in IEC IP68 enclosures, suitable for continuous submergence at a head of 20 feet of water.

B. Electric Motor Actuators (AC Reversing Control Type):

1. General: Where indicated, electric motor actuators shall be the AC reversing type.
2. Actuator Appurtenances: The actuator for each valve shall be supplied with open/close and fault ultra bright LED status lights; open, close and stop push buttons and lockable Local Off Remote selector switch and all other devices indicated.
3. Starter: The starter shall be a suitably sized amperage rated reversing starter with its coils rated for operation on 120-volt, 1-phase, 60-Hz current. A control power transformer shall be included to provide a 120-volt source, unless otherwise indicated. The starter shall be equipped with 3 overload relays of the automatic reset type. Its control circuit shall be wired as indicated. The integral weatherproof compartment shall contain a suitably sized 120-volt ac, single-phase, 60-Hz space heater to prevent moisture condensation on electrical components.
4. Manufacturers, No Equal:
 - a. Rotork IQ

C. Electric Motor Actuators (AC Modulating Control Type):

1. General: Where indicated, modulating electric motor actuators shall be the ac modulating type.
2. Control Module: The control module shall be of the electronic solid-state ac type with proportional pulse output to control the approach to setpoint speed of the motor.
3. Starter: The actuator shall control a solid-state reversing starter designed for minimum susceptibility to power line surges and spikes. The solid-state starter and control module shall be rated for continuous modulating applications up to 1200 starts per hour per IEC 34-1 to S4 50%. Power supply shall be 480-volt, 3-phase, 60-Hz.
4. Construction: The control unit shall be microprocessor-based and shall contain an analog/digital converter, separate input-output switches, non-volatile random access memory for storage of calibration parameters and push-button calibration elements for field-setup. Potentiometer adjustments shall contain a PID control function internally. In addition, the controller shall contain as standard feature a loss of command signal protection selectable to lock in last or lock in pre-set valve position and a valve position output signal in 4-20 mA. As an alternative to the construction requirement, the motor shall be capable of modulating at a rate 600 starts per hour at the 50 percent to 85 percent travel range of the valve.
5. Manufacturers, No Equal:
 - a. Rotork

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. General: Delivery and storage shall be in accordance with Section 15200 – Valves, General.

3.2 INSTALLATION

- A. All valve and gate actuators and accessories shall be installed in accordance with Section 15200 - Valves, General. Actuators shall be located to be readily accessible for operation and maintenance, without obstructing walkways. Actuators shall not be mounted where shock or vibrations will impair their operation, nor shall the support systems be attached to handrails, process piping, or mechanical equipment.

3.3 TESTING

- A. All valve actuators shall be tested in accordance with Section 15200 - Valves, General.

3.4 SUPPLEMENTS

- A. Special Constraints: Clearances at existing facilities are very tight. Contractor shall field verify all dimensions and existing conflicts prior to ordering material.

END OF SECTION

SECTION 15203 – CHECK VALVES

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall provide check valves and appurtenances, complete and operable, in accordance with the Contract Documents.
- B. The requirements of Section 15200 - Valves, General, apply to this Section.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

ANSI/ASME B16.1	Cast Iron Pipe Flanges and Flanged Fittings
ANSI/ASME B1.20.1	Pipe Threads, General Purpose
ANSI/ASME B16.5	Pipe Flanges and Flanged Fittings
ANSI/AWWA C508	Swing-Check Valves for Waterworks Service, 2-inch through 24-inch NPS
ASTM A126	Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM B16	Specification for Free-Cutting Brass Rod, Bar, and Shapes for Use in Screw Machines
ASTM A48	Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM B62	Specification for Composition Bronze or Ounce Metal Castings
ASTM B148	Specification for Aluminum-Bronze Sand Castings

1.3 CONTRACTOR SUBMITTALS

- A. The Contractor shall furnish submittals in accordance with Section 15200 - Valves, General.
- B. Shop Drawings: Shop drawings shall be in accordance with Section 15200 - Valves, General.
- C. Certifications: Certifications shall be in accordance with Section 15200 - Valves, General. Affidavit of compliance that check valves meet the requirements of the contract documents and the provisions of AWWA Standards where applicable.
- D. O & M manuals: O & M manuals shall be in accordance with Section 15200 - Valves, General.

1.4 QUALITY ASSURANCE

- A. Quality assurance shall be in accordance with Section 15200 - Valves, General.

1.5 MANUFACTURER'S SERVICE REPRESENTATIVE

- A. A manufacturer/supplier's representative shall be present at the job site for a minimum of one half man day, travel time excluded, for assistance during installation, equipment startup, testing, and training.

1.6 MANUFACTURER'S UNIT RESPONSIBILITY

- A. Unless otherwise indicated, a single Valve Manufacturer shall be made responsible for coordination of design, assembly, testing, and furnishing of each valve type; however, the Contractor shall be responsible to the Owner for compliance with the requirements of each valve type.

PART 2 PRODUCTS

2.1 SWING CHECK VALVES (3-INCH AND LARGER)

- A. General: Swing check valves for water, sewage, sludge, and general service shall be of the outside lever and spring or weight type, in accordance with ANSI/AWWA C508 - Swing-Check Valves for Waterworks Service, 2 in. through 24 in. NPS, unless otherwise indicated, with full-opening passages, designed for a minimum water-working pressure of 150 psi, unless shown on Contract Drawings or valve schedule. They shall have a flanged cover piece to provide access to the disc.
- B. Materials of Construction
 - 1. Body: The valve body and cover shall be of cast iron conforming to ASTM A126 - Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings, with flanged ends conforming to ANSI/ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 125, 250 or mechanical joint ends, as indicated.
 - 2. Disc: The valve disc shall be of cast iron, ductile iron, or bronze conforming to ASTM B62 - Specification for Composition Bronze or Ounce Metal Castings. The disc ring shall be of Buna-N.
 - 3. Seat: The valve seat shall be of bronze conforming ASTM B62 or B148 - Specification for Aluminum-Bronze Castings.
 - 4. Hinge Pin: The hinge pin shall be of bronze or stainless steel.
- C. Protective coating: Interior and exterior valve surfaces shall be coated in accordance with Section 15200 – Valves, General and Section 09960 – Protective Coatings.
- D. Manufacturers, or Equal:
 - 1. Milliken
 - 2. American Flow Control (American Cast Iron Pipe Company)

3. APCO (Valve and Primer Corporation)
4. Kennedy Valve
5. Mueller Company (Grinnell Corporation)

2.2 SWING CHECK VALVES (2-1/2-INCH AND SMALLER)

- A. General: Swing check valves for steam, water, oil, or gas in sizes 2-1/2-inch and smaller shall be suitable for a steam pressure of 150 psi and a cold water pressure of 300 psi. They shall have screwed ends, unless otherwise indicated, and screwed caps.
- B. Materials of Construction
 1. Body: The valve body and cap shall be of bronze conforming to ASTM B61 - Specification for Steam or Valve Bronze Castings, or ASTM B62 - Specification for Composition Bronze or Ounce Metal Castings, and with threaded ends conforming to ANSI/ASME B1.20.1 - Pipe Threads, General Purpose (inch).
 2. Disc: Valves for steam service shall have bronze or brass discs conforming to ASTM B16 - Specification for Free-Cutting Brass Rod, Bar, and Shapes for Use in Screw Machines, and for cold water, oil, and gas service replaceable composition discs.
 3. Hinge Pin: The hinge pins shall be of bronze or stainless steel.
- C. Protective coating: Interior and exterior valve surfaces shall be coated in accordance with Section 15200 – Valves, General and Section 09960 – Protective Coatings.
- D. Manufacturers, or Equal:
 1. Crane Company
 2. Milwaukee Valve Company
 3. Stockham Valves and Fittings
 4. Wm. Powell Company

2.3 INTERNAL SPRING-LOADED CHECK VALVES (GLOBE STYLE)

- A. General: Internal spring-loaded check valves for water pumps, compressors, gas, air, and steam shall be of the full-flow internal spring-loaded poppet type. The valves shall be designed for a water-working pressure of not less than 150 psi unless otherwise indicated.
- B. Materials of Construction
 1. Body: The bodies of all valves in sizes 3-inch and larger shall be of cast iron conforming to ASTM A126 - Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings, with 125-lb flanged ends conforming to ANSI/ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125,

250, and 800, unless otherwise indicated. Where necessary, there shall be a positive, watertight seal between the removable seat and the valve body. The stem guide shall be integrally cast with the body, or screwed into the body.

2. Valves smaller than 3 inches shall have bronze bodies with screwed ends conforming to ANSI/ASME B1.20.1 - Pipe Threads, General Purpose (inch), suitable for a minimum working pressure of 200 psi, and a temperature of 250 degrees F, unless otherwise shown indicated. The type of bronze shall be suitable for the intended service.
 3. Disc and Stem: The disc and stem of all valves in sizes 3-inch and larger shall be of bronze conforming to ASTM B584 - Specification for Copper Alloy Sand Castings for General Applications or stainless steel. The stem shall have two-point bearings. The downstream bearing shall have a bronze or other suitable bushing, to provide a smooth operation.
 4. Valves smaller than 3 inches shall have discs and retaining rings of Teflon, Nylon, or other suitable material, and stems of bronze, brass, or stainless steel, suitable for the intended service.
 5. Stem Guide: The stem guide must be either firmly fixed in the valve body to prevent it from sliding into the adjacent pipe and damaging the pipe lining, or the valve manufacturer shall furnish each valve with one matching flange compatible with the adjacent pipe and its lining to prevent damage to the lining. The compatible flange shall be part of the shop drawing submittal.
 6. Seat: All valves for general service at temperatures up to 250 degrees F shall have bubble-tight shut-off with resilient seats of Buna-N, Teflon, or other suitable material. Valves for steam service and temperatures over 250 degrees F shall have metal-to-metal seating of bronze or stainless steel, as recommended by the manufacturer for the specific service condition. All resilient seats shall be firmly attached to the seating ring by compression-molding or other acceptable method.
 7. Spring: All valves in sizes 3-inch and larger shall have Type 316 stainless steel springs, and valves smaller than 3-inch shall have stainless steel or beryllium copper springs, as suitable for the service. The spring tension of the valves shall be designed for the individual pressure condition of each valve.
- C. Protective coating: Interior and exterior valve surfaces shall be coated in accordance with Section 15200 – Valves, General and Section 09960 – Protective Coatings.
- D. Manufacturers, or Equal:
1. APCO (Valve and Primer Corp.)
 2. CPV (Combination Pump Valve Company)
 3. Miller Valve Co., Inc.
 4. VAL-MATIC (Valve and Manufacturing Corporation)

2.4 DOUBLE-LEAF CHECK VALVES

- A. General: Double-leaf check valves for air and gas service and where indicated, shall be of the wafer-type designed to fit between ANSI B16.1 flanges for 125-lb rating. The check valve leaves shall be spring-loaded. Flow from one direction shall cause the valve to open, and upon valve shutoff, the spring shall shut the valve leaves before reverse flow starts and at a point of zero velocity, for non-slam closure. The spring-tension of each valve shall be designed for the individual operating condition.
- B. Materials of Construction
 - 1. Body: The valve body shall be of cast iron conforming to ASTM A126 - Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings with integrally-cast seat, rated for minimum 150-lb working pressure at up to 250 degrees F.
 - 2. Leaves: The leaves shall be of bronze, aluminum bronze, or ductile iron, revolving on stainless steel or monel hinge pins with retainers.
 - 3. Seat: The valves shall have resilient seats for bubble-tight shut-off, suitable for temperatures up to 250 degrees F without sticking. The seats shall be Buna-N, Viton, or other suitable material for the intended purpose. The seat rings shall be firmly attached a shoulder cast in the body or to the disc by compression-molding or similar acceptable method.
 - 4. Springs: The springs shall be of Type 316 stainless steel, or Inconel, as best suited for the service condition.
- C. Protective coating: Interior and exterior valve surfaces shall be coated in accordance with Section 15200 – Valves, General and Section 09960 – Protective Coatings.
- D. Manufacturers, or Equal:
 - 1. APCO (Valve and Primer Corporation)
 - 2. Milliken
 - 3. VAL-MATIC (Valve and Manufacturing Corporation)

2.5 SLANTING DISC CHECK VALVES

- A. General: Slanting disc check valves for water service shall have a seating angle of approximately 55 degrees. Valves shall have replaceable seat rings and disc rings. The water passage cross-sectional area shall be equal to the full pipe area. Valves shall have sufficient clearance around the pivot pins to permit free seating of the disc without binding and shall be guaranteed not to stick in the closed position. All slanting disc check valves shall have position indicators and two flanged connections for attachment of dashpots or hydraulic snubbers. The valves shall be designed for a water working pressure of 150 psi, unless otherwise indicated.
- B. Materials of Construction

1. Body: The valve body shall be of cast iron conforming to ASTM A48 - Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings or A126 - Specification for Gray Iron Castings, class B, with flanged ends conforming to ANSI/ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800, Class 125, unless otherwise indicated.
 2. Disc: The valve disc shall be designed with an "aerofoil" configuration of cast iron or ductile iron, with bronze seating face, except for valves 10 inches or smaller, which may have solid bronze or aluminum bronze discs. The disc shall be partially balanced with a short travel, to resist slamming.
 3. Seat Ring: The seat ring shall be of centrifugally cast bronze, aluminum bronze, or stainless steel, with beveled edges, firmly clamped or screwed into the valve body.
 4. Pins: The pivot pins and bushings shall be of stainless steel, bronze, or aluminum bronze, to allow free movement of the disc without binding.
- C. Dashpot: A top mounted hydraulic dashpot shall be provided to control the opening and closing cycle of the valve to prevent surge and water hammer. The dashpot shall have two control flow rates:
1. 90 percent rapid rate and
 2. 10 percent slow rate during shut down and start up. Each rate shall be infinitely and independently adjustable. The dashpot shall be a self contained oil system separate and independent from the water line media. The oil reservoir for the closing cycle shall be stainless steel and open to the atmosphere with an air breather cap to prevent oil spillage. The oil reservoir for the opening cycle shall be stainless steel and hermetically sealed to contain pressure (air over oil) and be equipped with a 3-inch diameter pressure gage and pneumatic fill valve. There shall be a provision for disconnecting the dashpot from the valve for servicing, without removal of the valve.
- D. Protective coating: Interior and exterior valve surfaces shall be coated in accordance with Section 15200 – Valves, General and Section 09960 – Protective Coatings.
- E. Manufacturers, or Equal:
1. APCO (Valve and Primer Corporation)
 2. Crane Company (Without Dashpot, Only)
 3. VAL-MATIC (Valve and Manufacturing Corporation)

2.6 PLASTIC BALL CHECK VALVES

- A. General: Plastic ball check valves for corrosive fluids, in sizes up to 4-inch, shall be used for vertical up-flow conditions only, unless the valves are provided with spring actions. The valves shall be suitable for a maximum working non-shock pressure of 150 psi at 73 degrees F.

B. Materials of Construction

1. The valve bodies and balls shall be of polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC), polyvinylidene fluoride (PVDF), or polypropylene (PP) construction, as best suited for each individual service condition. They shall have unions with socket connections, or flanged ends conforming to ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings, class 150. All seals shall have Viton O-rings and valve design shall minimize possibility of the balls sticking or chattering.

- C. Protective coating: Interior and exterior valve surfaces shall be coated in accordance with Section 15200 – Valves, General and Section 09960 – Protective Coatings.

D. Manufacturers, or Equal:

1. ASAHI-AMERICA
2. George Fischer, Inc.
3. NIBCO Inc. (Chemtrol Division)

2.7 PLASTIC SWING OR Y-CHECK VALVES

- A. General: Plastic swing or Y-check valves for corrosive fluids, in sizes up to 8 inches or as available, may be used for horizontal or vertical up-flow conditions. The PVC valves shall be rated for a maximum non-shock working pressure of 150 psi at 73 degrees F for sizes 3-inch and smaller. For larger sizes and other materials and temperatures the pressure rating will be lower.

B. Materials of Construction

1. The valve bodies and discs or piston shall be of PVC, PP, or PVDF construction, as best suited for each individual service condition. They shall have flanged ends conforming to ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings, class 150, and flanged top access covers, and they shall shut positively at no-flow conditions. The seats and seals shall be of EPDM, Teflon, or Viton.

- C. Protective coating: Interior and exterior valve surfaces shall be coated in accordance with Section 15200 – Valves, General and Section 09960 – Protective Coatings.

D. Manufacturers, or Equal:

1. ASAHI-AMERICA
2. George Fischer, Inc.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. General: Delivery and storage shall be in accordance with Section 15200 – Valves, General and applicable requirements.

3.2 INSTALLATION

- A. The Contractor shall install the valves in accordance with the manufacturer instructions and Contract Documents.
- B. All valves shall be installed in accordance with Section 15200 - Valves, General.

3.3 TESTING

- A. All valves shall be tested in accordance with Section 15200 - Valves, General.

END OF SECTION

SECTION 15214 – PRESSURE CONTROL VALVES

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall provide pressure reducing valves and appurtenances, complete and operable, in accordance with the Contract Documents.
- B. The requirements of Section 15200 - Valves, General, apply to this Section.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

ASTM A48	Specification for Gray Iron Castings
ASTM A126	Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A536	Specification for Ductile Iron Castings
ASTM B62	Specification for Composition Bronze or Ounce Metal Castings
ANSI/ASME B16.1	Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800.
ANSI/ASME B16.42	Ductile Iron Pipe Flanges and Flanged Fittings.
ANSI/ASME B16.5	Pipe Flanges and Flanged Fittings, Class 125, 150, 250, or 300

1.3 CONTRACTOR SUBMITTALS

- A. The Contractor shall furnish submittals in accordance with Section 15200 - Valves, General.
- B. Shop Drawings: Shop drawings shall be in accordance with Section 15200 - Valves, General.
- C. Certifications: Certifications shall be in accordance with Section 15200 - Valves, General. Affidavit of compliance that valves meet the requirements of the contract documents and the provisions of AWWA Standards where applicable. A hydrostatic factory and functional test certificate shall be submitted to the Engineer prior to delivery of the valve.
- D. O & M manuals: O & M manuals shall be in accordance with Section 15200 - Valves, General.

1.4 QUALITY ASSURANCE

- A. Quality assurance shall be in accordance with Section 15200 - Valves, General.

1.5 MANUFACTURER'S SERVICE REPRESENTATIVE

- A. A manufacturer/supplier's representative shall be present at the job site for up to two man days, travel time excluded, for assistance during installation, equipment startup, and testing.
- B. Instruction of Owner's Personnel: The training representative of the valve manufacturer shall be present at the site for up to 1 work days to instruct the personnel in the operation, adjustment, and maintenance of the valve(s).

1.6 MANUFACTURER'S UNIT RESPONSIBILITY

- A. Unless otherwise indicated, a single Valve Manufacturer shall be made responsible for coordination of design, assembly, testing, and furnishing of each valve type; however, the Contractor shall be responsible to the Owner for compliance with the requirements of each valve type.

PART 2 PRODUCTS

2.1 PRESSURE REDUCING VALVES, SIZES 1 TO 12 INCHES

- A. General: Pressure reducing valves shall reduce a higher upstream pressure to a pre-set, lower, constant pressure, regardless of fluctuations in the upstream pressure. When downstream pressure increases above a pre-set pressure the valve closes. The valves shall be hydraulically operated, with diaphragm or piston direct action, pilot-controlled, and shall be of the wafer, flanged, or victaulic ends as indicated.
- B. Materials of Construction
 - 1. Body: The valve body shall be bronze to ASTM B62 or cast steel or cast iron to ASTM A48 - 125 lb or 250 lb flanged ends to ANSI/ASME B16.1 or ductile iron to ASTM A536 - 150 lb or 300 lb flanged ends to ANSI/ASME B16.42, with a minimum pressure rating of 300 psi. The valve shall be provided with an integral or an attached strainer with access cap or plug and a flanged or threaded valve cover. The valve shall be actuated by a diaphragm.
 - 2. Flange: ANSI B16.5 Class 125, 150, 250, or 300, as indicated.
 - 3. Liner: Natural rubber, 65 durometer, Viton, EPDM, Nitrile, or Silicone as indicated. Liner retainer shall be 316 stainless steel.
 - 4. Valve Trim: The valve stems, springs, body seats, and washers shall be of 316 stainless steel. The strainers shall be of stainless steel or monel and the diaphragms shall be of reinforced neoprene. The valve pistons and piston liners shall be bronze to ASTM B62.

- C. Spare Parts: The following spare parts shall be furnished in accordance with Section 15200:
 - 1. One liner (for piston valves, only (Golden-Anderson or Ross)).
 - 2. One diaphragm (for diaphragm valves, only).
- D. Protective coating: Interior and exterior valve surfaces shall be coated in accordance with Section 15200 – Valves, General and Section 09960 – Protective Coatings.
- E. Manufacturers, or Equal:
 - 1. Cla-Val Company.
 - 2. Watts, ACV.
 - 3. OCV Control Valves
 - 4. Bermad Control Valves

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. General: Delivery and storage shall be in accordance with Section 15200 – Valves, General.

3.2 INSTALLATION

- A. All valves shall be installed in accordance with provisions of Section 15200 – Valves, General.

3.3 TESTING

- A. All pressure control valves shall be tested in accordance with Section 15200 - Valves, General.
- B. Factory Tests and Warranty: All valves shall be factory tested with a hydrostatic test and a functional test. The valve shall be warranted for a period of 3 years from the date of shipment to be free of defects in materials and workmanship.

END OF SECTION

SECTION 15230 – MISCELLANEOUS VALVES

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall provide all miscellaneous valves and appurtenances, complete and operable, in accordance with the Contract Documents.
- B. The requirements of Section 15200 - Valves, General, apply to this Section.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. AWWA C511 Standard for Reduced-Pressure Principle Backflow Prevention Assembly

1.3 CONTRACTOR SUBMITTALS

- A. The Contractor shall furnish submittals in accordance with Section 01330 – Submittal Procedures.
- B. Shop Drawings: Shop drawings shall contain, at a minimum, the following information:
 - 1. Valve name, size, pressure rating, and identification number (if applicable).
 - 2. Complete information on valve actuator, including sizing calculations, manufacturer, model number, limit switches, and mounting.
 - 3. Assembly drawings showing part nomenclature, materials, dimensions, weights, position indicators, limit switches, integral control systems, needle valves, and control systems.
 - 4. Complete wiring diagram and control system schematics.
- C. Certifications: Certifications shall be in accordance with Section 15200 - Valves, General. Affidavit of compliance that valves meet the requirements of the contract documents and the provisions of AWWA Standards where applicable.
- D. O & M manuals: O & M manuals shall be in accordance with Section 15200 - Valves, General.

1.4 QUALITY ASSURANCE

- A. Quality assurance shall be in accordance with Section 15200 - Valves, General.

1.5 MANUFACTURER'S SERVICE REPRESENTATIVE

- A. A manufacturer/supplier's representative shall be present at the job site for up to one half man day, travel time excluded, for assistance during installation, equipment startup, testing, and training.

1.6 MANUFACTURER'S UNIT RESPONSIBILITY

- A. Unless otherwise indicated, a single manufacturer shall be made responsible for coordination of design, assembly, testing, and furnishing of each valve type; however, the Contractor shall be responsible to the Owner for compliance with the requirements of each valve type.

PART 2 PRODUCTS

2.1 SOLENOID VALVES

- A. General: Solenoid valves shall be of the size, type, and class indicated and shall be designed for not less than 150 psi water-working pressure.
- B. Materials of Construction: Valves for water, air, or gas service shall have brass or bronze body with screwed ends, stainless steel trim and spring, Teflon, or other resilient seals with material best suited for the temperature and fluid handled. Solenoid valves in corrosive environment shall have stainless steel bodies. For chemicals and all corrosive fluids, solenoid valves with Teflon bodies and springs or other suitable materials shall be used. Enclosures shall be NEMA rated in accordance with the area designations of Section 16050 – General Requirements for Electrical Work. All coil ratings shall be for continuous duty. For electrical characteristics, see electrical drawings or Specifications.
- C. Manufacturers, or Equal:
 - 1. For General Duty:
 - a. Automatic Switch Co. (ASCO), Model "RED HAT"
 - b. Skinner Valve-Honeywell, Inc.
 - c. Magnatrol Valve Corporation
 - d. J. D. Gould Co.
 - 2. For Corrosive Fluids:
 - a. Valcor Engineering Corporation
 - b. +GF+ Plastic Systems, Inc.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. General: Delivery and storage shall be in accordance with Section 15200 – Valves, General and applicable requirements.

3.2 INSTALLATION

- A. Backflow preventers shall be installed in potable water lines where required by applicable codes or regulations, and wherever there is any danger of contamination, and where indicated.

- B. All valves shall be installed in accordance with the manufacturer's printed recommendations, and with provisions of Section 15200 – Valves, General.
- C. All backflow preventers, as well as air and vacuum release valves, shall have piped outlets to the nearest acceptable drain, firmly supported, and installed in such a way as to avoid splashing and wetting of floors and obstruction of traffic.

3.3 TESTING

- A. All valves shall be tested in accordance with Section 15200 - Valves, General.

END OF SECTION

SECTION 15250 – HYDRAULIC GATES

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall furnish and install all tools, supplies, materials, equipment, and labor necessary for the installation, testing, and placing into operation of all hydraulic gates with appurtenances, complete and operable, in accordance with the requirements of the Contract Documents.
- B. The provisions of this Section shall apply to all hydraulic gates specified, except where otherwise specified in the Contract Documents.
- C. The requirements of Section 15201 – Valve and Gate Actuators, apply to this Section.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Without limiting the generality of other requirements of these Specifications, all work specified herein shall conform to or exceed the requirements of all applicable codes and regulations.

1.3 CONTRACTOR SUBMITTALS

- A. General: CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished this Section and in referenced Sections in accordance with the requirements of Section 01330 – Submittal Procedures.
- B. Shop Drawings and Samples: In addition to the requirements of Section 01330 – Submittal Procedures, CONTRACTOR shall submit the following:
 - 1. Gate name, size, pressure rating, identification number (if any), and Specification Section number.
 - 2. Complete information on gate actuator, including sizing calculations, manufacturer, model number, limit switches, and mounting.
 - 3. Assembly drawings showing part nomenclature, materials, dimensions, weights, and relationships of gate handles, handwheels or cranks, position indicators, limit switches, integral control systems, and control systems.
 - 4. Complete wiring diagrams and control system schematics.
 - 5. Gate Labeling: A schedule of gates to be labeled, indicating in each case the location and the proposed wording for the label.
- C. O & M Manuals

1. Prior to start-up, the CONTRACTOR shall provide operations and maintenance data for all equipment furnished for the project in accordance with Section 01730 - Operation and Maintenance Data.
 2. Manuals shall include printed instructions relating to proper maintenance, including lubrication, and parts lists indicating the various parts by name, number, and diagram where necessary, shall be furnished in duplicate with each unit or set of identical units. Instructions for field procedures for erection, adjustments, inspection, and testing shall be provided prior to installation of the gates.
- D. Tools: Special tools necessary for maintenance and repair of the hydraulic gates shall be furnished as a part of the Work hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.
- E. Quality Assurance: CONTRACTOR shall submit the following:
1. Manufacturer's Certificate of Proper Installation
 2. Functional Test Certification
 3. Factory performance test reports
 4. Special shipping, storage and protection, and handling instructions
 5. Manufacturer's printed installation instructions
 6. Spare parts list: The CONTRACTOR shall obtain from the manufacturer, a list of suggested spare parts of all items subject to wear, such as seals, packing, gaskets, nuts, bolts, washers, etc., including all spare parts to maintain the equipment in service for a period of 5 years.
 7. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup. Include a list of special tools required for checking, testing, parts replacement, and maintenance.
 8. Certification: The CONTRACTOR shall obtain written certification from the designated single manufacturer, addressed to the OWNER, stating that the equipment will efficiently and thoroughly perform the required functions in accordance with these Specifications and as shown, and that the designated single manufacturer accepts the CONTRACTOR'S assignment of full responsibility for coordination of all equipment, including actuators and controls, and services required for proper installation and operation. The CONTRACTOR shall submit all such certificates to the ENGINEER.
 9. Guarantees, Warranties: After completion, the CONTRACTOR shall furnish to the OWNER the manufacturer's written guarantees, that the hydraulic gates will meet these specifications. The CONTRACTOR

shall also furnish the manufacturer's warranties as published in its literature and as specified.

1.4 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: All gate manufacturers shall have a successful record of not less than 5 years in the manufacture of the gates indicated.
- B. All manufactured items provided under this Section shall be new, of current manufacture, and shall be the products of reputable manufacturers specializing in the manufacture of such products; such manufacturers shall have had previous experience in such manufacture and shall, upon request of the ENGINEER, furnish the names of not less than 5 successful installations of its equipment of comparable nature to that offered under this contract.
- C. Warranty: A written warranty shall be provided for the equipment specified in this section as required in Section – 01785 Warranties and Bonds.

1.5 MANUFACTURER'S SERVICE REPRESENTATIVE

- A. Manufacturer's Representative. In accordance with the requirements of Section 01660 – Testing and Adjusting, a Manufacturer's Representative shall be present at the site or classroom designated by the OWNER to provide the services and minimum person-days listed below, travel time excluded.
 - 1. 1 person-days for installation assistance and inspection,
 - 2. 1 person-days for functional and performance testing
 - 3. 1 person-days for pre-startup training of OWNER'S personnel.
- B. These services, and minimum person-days listed above, shall be provided for each gate type to be installed at the job site.
- C. No additional compensation shall be provided for the services of the manufacturer's service representative.

PART 2 PRODUCTS

2.1 GENERAL

- A. All combinations of manufactured equipment which are provided under these Specifications shall be entirely compatible, and the CONTRACTOR and the listed manufacturer shall be responsible for the compatible and successful operation of the various components of the units conforming to specified requirements. All necessary mountings and appurtenances shall be included.
- B. All gates shall have all of the features shown in the contract drawings, and in the supplemental gate schedule in the Plans.
- C. Materials of construction

1. General: All materials employed in the manufacture and installation of the hydraulic gates and actuators 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.
2. Nuts and Bolts: All nuts and bolts gates and supports shall be in accordance with Section 05500 – Miscellaneous Metals.
3. Gate Actuators: All gate actuators, regardless of type, shall be manufactured, installed, adjusted, and tested by the gate manufacturer at the manufacturer plant. All gates shall open counter-clockwise unless otherwise shown or specified.

D. Performance requirements

1. All gates shall be furnished complete with the accessories required to provide a functional system.
2. Refer to the Supplemental Gate Schedule, attached to this Specification, for specific gate requirements.
3. The leakage allowance for each type of gate shall be as specified in each gate section and as required in the applicable ANSI/AWWA Standard.

E. Actuators

1. Unless otherwise indicated, gate and valve actuators shall be in accordance with Section 15201 – Valve and Gate Actuators.
2. The electric actuators for all gates and valves shall be of the same actuator manufacturer. The CONTRACTOR shall be responsible to coordinate this among the gate and valve vendors.
3. Actuators:
 - a. Actuators shall be electric motor, handcrank, handwheel, or operating nut type as shown.
 - b. Weatherproof: Unless otherwise shown, actuators shall be weatherproof.
 - c. Pedestals: Actuators shall be pedestal mounted type unless otherwise shown. Pedestals shall be of cast-iron or fabricated steel. The pedestal shall have an ample base or wall-bracket area to evenly distribute the load to the supporting concrete structure. Unless otherwise shown, wall-brackets for the actuator and intermediate stem guides shall be provided
 - d. Stem and stem covers: The operating stem shall be the rising stem type with plastic covers unless otherwise shown. Rising stem gates shall be provided with clear polycarbonate stem covers ASTM D3935/D707. Vent holes shall be provided to

prevent condensation. Stems shall be equipped with position indicators.

- e. Manual lifts: Removable cast iron handwheels shall have a solid rim, be smooth and free of sharp edges and have an arrow to show the direction of the opening. Geared lifts shall have directional arrows and revolving brass grips. The maximum radius of the handwheel shall be 15 inches. All manual lifts shall be furnished with a bronze stop nut to limit the downward travel of the stem and slide. Clockwise movement of the handwheel shall close the gate. Where indicated, the shaft shall terminate in a 2-inch square operating nut in lieu of the handwheel.
 - f. Electric motor actuators: Gates shall be provided with electric actuators in accordance with Section 15201 - Valve and Gate Actuators, and the recommendations of the gate manufacturer.
 - g. The center line of actuator shall be approximately 3 feet above the base of the pedestal.
 - h. Gate hoist heads shall be cast iron. The operating nut shall be of solid bronze conforming to ASTM B 584. Roller or ball bearings shall be included for thrust. Bearings and stem shall be provided with a lubrication system.
 - i. Crank: The unit shall be designed for a maximum of 40 lb on the crank to operate the gate. The operating crank shall be readily removable to facilitate the use of a portable power actuator. The direction of crank rotation to open the gate shall be indicated on the lifting mechanism.
- F. Frames: All slide gates shall be of the self-contained frame type, unless otherwise indicated on the contract drawings or on the supplemental gate schedule, attached to this Specification.
- G. Protective Coating: The exterior surfaces and the wet interior surfaces of all ferrous gates shall be coated in accordance with Section 09960 – Protective Coatings. The gate Manufacturer shall certify in writing that the required coating has been applied and tested in the manufacturing plant prior to shipment, in accordance with these Specifications. Flange faces of gates shall not be epoxy coated. Where surfaces have been shop painted but have been damaged during delivery, storage, or assembly, or where shop coats have deteriorated, these surfaces shall be properly cleaned and retouched or repainted with matching paint.
- H. Spare Parts: Where indicated, the CONTRACTOR shall furnish the required spare parts suitably packaged and labeled with the gate name, location, and identification number. The CONTRACTOR shall also furnish the name, address, and telephone number of the nearest distributor for the spare parts of each gate. All spare parts are intended for use by the OWNER, only after expiration of the guarantee period.

2.2 SLIDE/ STOP GATES

A. GENERAL

- 1. All gates shall be new and of current manufacture, and adequately braced to prevent warpage and bending under the intended use. The

gate slide shall be designed such that it will not deflect more than 1/1000 of the span of the gate at any point under the design head shown on the supplemental gate schedule, attached to this Specification. Where designated, gates shall be furnished with electric actuators.

2. All slide and stop gates shall be in accordance with the applicable ANSI/AWWA Standard.
3. Performance Requirements: The leakage allowance for all slide and stop gates shall not exceed 0.1 gpm/ft of seating perimeter under the design head, seating or unseating as specified, to meet ANSI/AWWA C561, C562, C563 and C513.
4. Mounting Hardware: Mounting hardware, if required, shall be of the size and type recommended by the gate manufacturer and shall be furnished as part of the guide frame.
5. Slide/Sluice Gates
 - a. Frames: Frames shall have the following design characteristics:
 - 1) Guide Length: Sufficient to retain at least 2/3 of gate slide when gate is in fully open position.
 - 2) Additional Supports: Support guides as required to prevent buckling due to actuator forces using a slenderness ratio of $L/r < 200$.
 - 3) Yoke to Support Bench Stand Actuator: Form by 2 angles welded to gate frame. Deflection shall be less than $L/360$.
 - 4) Yoke Arrangement: Capable of allowing removal of slide.
 - 5) Gate frames shall be fitted with fixed sealing faces that surround the clear opening. The fixed sealing and sliding faces shall be ultra high molecular weight polyethylene.
 - b. Stems: Stems shall be of Type 316 or other approved stainless steel conforming to ASTM A276 and shall be provided with adjustable bronze bushed stem guides to ensure that the L/R ratio of the stem does not exceed 200. The stems shall have stub acme machined rolled or cut threads, double lead, finished or polished to 32 micro-inch finish or better.
 - c. Operating Nut: The operating nut shall be of solid bronze, ASTM B584. Operating thrust shall be taken on roller or ball bearings. All parts shall be provided with an alternate lubrication system. Operating nut threads shall match stem threads.
 - d. Seals: All fabricated slide and stop gates shall be provided with resilient neoprene seals along the sides and across the top of the opening where submerged. A flush button removable neoprene seal shall be provided on the invert of all fabricated slide gates. Seat seals attached to the slide gate will not be acceptable. Seals shall be mounted such that they do not protrude into the specified opening of the gate. All slide and stop gates will have ultra high molecular weight polymer seat seals having an intrinsic viscosity of greater than 14 by test. The seat seals shall be provided on both upstream and downstream faces of the slide and shall be

mechanically locked in the gate guides, The UHMW seat seals will be shaped to provide two bearing surfaces and two sealing edges on each face of the slide. The slide will be a tight fit between the sealing edges to limit leakage]

- e. Gates requiring top closure: Gates to be installed where water levels exceed the top of the slide shall be equipped with top closure. Top closure shall consist of neoprene double lip seals along the top and sides of the gate opening. These seals shall be mounted on an additional perimeter frame and shall not protrude into the waterway. Lip seal attachment shall be stainless steel fasteners and retaining strips. The perimeter frame shall not require boxing out the edges of the gate opening.

B. STAINLESS STEEL SLIDE GATES

- 1. Materials of construction: Gate frame, slide and stem shall be made of type 316 stainless steel. Fasteners and anchor bolts shall also be of Type 316 stainless steel.
- 2. The minimum diameter of the stem shall be one inch.
- 3. Manufacturers, or Equal:
 - a. Rodney Hunt Company.
 - b. Hydro Gate Corp.
 - c. Waterman Industries, Inc.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. A complete set of manufacturer's instructions covering storage, installation, operation, lubrication, and maintenance shall be furnished to the OWNER no later than the date the equipment is shipped. Care during storage and procedures for installation, lubrication, and startup of the equipment and motors shall be in strict conformance with the manufacturer's instructions
- B. The CONTRACTOR shall prepare and load all material and articles for shipment in a manner that protects the equipment and coatings from damage in transit, shall include a packing list, and shall be responsible for and make good on any and all damage.
- C. All accessories and spare parts shall be packed separately in containers plainly marked "ACCESSORIES ONLY" or "SPARE PARTS ONLY." All packing materials shall be fire retardant. A packing list, listing the contents of each container, shall be placed in a moisture proof envelope, and securely fastened to the outside of the container.

3.2 INSTALLATION

- A. Hydraulic gates shall be installed in accordance with the manufacturer's printed recommendations and the requirements herein, the procedures submitted with the CONTRACTOR-approved shop drawings and as shown, unless otherwise acceptable to the ENGINEER.
- B. Actuators shall be located to avoid interference with handrails and structural members.
- C. Sluice and shear gates: Just prior to setting each gate, a 1/8-inch thick layer of mastic grade polysulfide elastomeric sealant shall be applied to the back of the gate frame. After setting the gate the nuts shall be run down on the anchor bolts just far enough to make them snug and to cause the rubber sealant to begin to ooze out, but not far enough to produce any significant stress to the frame. Any excess sealant at the edges shall be removed. The sealant shall be allowed to cure for at least 7 days, after which the anchor bolt nuts shall be tightened to their final positions. If gaskets are being used, they shall be installed over the studs in one piece or dovetailed and cemented with a liquid-type gasket material.
- D. Slide gates shall be installed in accordance with the applicable AWWA standard.
- E. Alignment: Equipment shall be field tested to verify proper alignment, operation as specified, and freedom from binding, scraping, or other defects. Equipment shall be secure in position and neat in appearance.
- F. Lubricants: The installation work shall include furnishing the necessary oil and grease for initial operation.
- G. All damage to surface coatings incurred during shipment and/ or installation shall be repaired to the satisfaction of the ENGINEER prior to installation.
- H. Cleanup: After completion of the installation and testing, the CONTRACTOR shall remove all debris from the site, clean all the equipment and controls, and hand over his work in perfect operating condition.

3.3 TESTING

- A. General:
 - 1. All gate testing shall be in accordance with applicable standards of AWWA, ANSI, and ASTM.
 - 2. Provide testing in accordance with Section 01650 – Facility Start up.
 - 3. The CONTRACTOR shall be responsible for the coordination of the tests of each hydraulic gate with actuators, in the presence of the manufacturer's factory service representative. Any excessive leaks shall be corrected and the equipment retested until found satisfactory. Field testing will be witnessed by the ENGINEER. The CONTRACTOR shall furnish three days advance notice of field testing.

- B. Performance Testing: If leakage exceeds the indicated criteria, modifications and corrections shall be made under the supervision of manufacturer's representative at no additional cost to the OWNER.

END OF SECTION

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SECTION 15430 - PLUMBING PIPING AND SPECIALTIES

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall furnish and install plumbing and specialties as shown, complete and operable with electrical connections of hook-ups as specified herein and in accordance with the Contract Documents.

1.2 WORKMANSHIP AND MATERIALS

- A. All work shall be in strict accordance with the Uniform State Plumbing Code, and codes of the State of California, and any other authorities having jurisdiction. The Contractor shall have required certifications and be thoroughly familiar with the local codes. The Contractor shall obtain and pay for all necessary permits.
- B. Care shall be taken at all times to protect floors, stairways, and walls during the makeup, erection of piping, and placing of equipment. The Contractor shall remove all stains and repair all damage before final acceptance of the work.
- C. If, during the construction of this project, the Engineer finds materials that have identifying marks removed or lack such marks completely, he may reject such items until the Contractor has furnished proof that said items conform to the Specifications. Adequacy and extent of such proof shall be determined by the Engineer.

1.3 CONTRACTOR SUBMITTALS

- A. O & M Manuals: The CONTRACTOR shall provide operators and maintenance data for all equipment furnished for the project in accordance with Section 01782, Operating and Maintenance Data.

PART 2 PRODUCTS

2.1 GENERAL

- A. Plumbing piping, fixtures, specialties, and equipment shall be as recommended by the manufacturer for the intended usage.
- B. Floor drains or floor sinks shall be provided for all equipment drains. No equipment drains shall discharge to floor slabs.
- C. Painting
 - 1. All ferrous metal, except finished, galvanized and machine surfaces, shall have surfaces prepared and primed in the shop in accordance with the requirements of Section 09960 – Protective Coatings. Prime colors shall be compatible with finish coats to be applied in the field.

2. Self contained units such as wall-mounted hose racks shall be supplied with factory applied finish coats of baked enamel.
3. All field painting shall comply with Section 09960 – Protective Coatings.

2.2 PIPING AND FITTINGS

- A. All cast iron sanitary, storm, and vent pipe and fittings shall be manufactured in accordance with and shall meet the requirements of ASTM A74 - Cast Iron Soil Pipe and Fittings. Dimensions of cast iron soil pipe and fittings shall be as given in Table 2 of ASTM A74.
- B. Hub-Less cast iron soil pipe and fittings with Clamp-All Type pipe couplings, or equal, shall be used for above ground sanitary, storm, and vent piping where approved for use by local authorities. Hub-Less cast iron soil pipe and fittings shall meet CISPI Standard 301. Pipe couplings shall have Hi-Torque capacity and meet FM Standard 1680.
- C. All copper pipe and fittings for potable and service water 3 inches and smaller shall be Type L medium wall hard temper copper pipe with soldered fittings.
- D. Vent piping passing through the roof shall be flashed. Flashing shall extend a minimum 12 inches from the outer surface of the pipe in all directions. Flashing shall be fabricated from 4-pound lead sheet.

2.3 INSULATION

- A. All piping, valves, and fittings shall be provided with insulation as shown or required by the manufacturer and in accordance with the requirements indicated.

2.4 HANGERS, SUPPORTS, AND MISCELLANEOUS METAL WORK

- A. General: The Contractor shall provide all necessary hangers and supports. No perforated strap hangers and no wire supports will be permitted. Pipe supports shall be as indicated in Section 15006 – Pipe Supports.
- B. Hangers supporting insulated piping shall be sized to fit the pipe plus the insulation. Insulation at support points shall be provided with metal shields to prevent damage to the insulation.
- C. Spacing:
 1. Pipe support spacing for steel and cast iron pipe is given in Section 15006 – Pipe Supports.
 2. Copper pipe support spacing shall be not more than 6 feet between supports.
- D. Rod sizes for pipe hangers shall be as recommended by the hanger manufacturer.
- E. Pipe hangers used to support uninsulated copper piping shall be copper or copper plated.

- F. All vertical piping shall be supported at the base with fittings made for this purpose or supported from the nearest horizontal member or floor with a riser extension pipe clamp.
- G. Anchors that are installed into existing concrete shall be Grinnel Figure 117, Modern Figure 740, or equal expansion case inserts. Drill clean holes for insertion of case and patch concrete around hole as required.
- H. Continuous slotted concrete inserts, if used, shall be Crawford Figure 148, Fee & Mason Figure 9000, or equal. The Contractor shall provide secondary angle supports between main inserts to handle the loads which can be properly supported by such arrangement.
- I. Concrete inserts shall be as indicated in Section 15006 – Pipe Supports. All inserts shall be galvanized.

2.5 PIPE SLEEVES

- A. Where pipes pass through floors, sleeves shall extend 3 inches above the finished floor. Where pipes pass through walls, sleeves shall be flush with the wall surface.
- B. All sleeves shall be Schedule 40 galvanized steel pipe, one size larger than the pipe passing through, or where pipe is insulated, one size larger than the pipe plus insulation.
- C. All buried or submerged pipe sleeves shall be coated by the manufacturer with a fusion bonded epoxy in accordance with the requirements of Section 09960 – Protective Coatings.

2.6 VALVES

- A. All valves shall be as indicated and shall conform to the requirements of the applicable Section(s) of these Specification.
- B. The Contractor shall provide shutoff valves on cold water piping at entrances to pipe chases and other inaccessible areas and wherever indicated or required to obtain the maximum efficiency for shutoff control on the water system. Shutoff valves shall be placed on all hot and cold water connections to equipment and fixtures. Lavatory and sink stops with wheel handle shall be brass with chrome plating. Extra long barrel stops shall be used where supply piping is concealed behind partitions.
- C. All valves shall open by turning counterclockwise and shall have suitable handwheels or nuts as required.
- D. Provide a temperature and pressure relief valve for each water heater. Provide pressure relief valves at other locations where indicated. Relief valves shall be equipped with manual test levers. The Contractor shall provide piping to convey relief valve discharge to the nearest floor drain, the building exterior, or as approved by the Engineer.

2.7 HOSE BIBBS

- A. General: All hose bibbs in exposed locations subject to freezing shall be the non-freeze type. Hose bibbs connected to a non-potable water supply shall be provided with plastic or stainless-steel warning signs as specified in Section 10400 – Identifying Device. Where indicated, hose bibbs shall be provided with vacuum breakers as furnished by Crane Co., American Standard, or equal.
- B. Manufacturers, or Equal:

Fixture Type	Description
Non-freeze post-type	Exposed bronze hydrant, post-type, depth of bury as indicated on drawings or to suit local conditions; minimum 4 feet. 1. Iowa Woodward, Model Y1. 2. Zurn, Model Z13857 or Z1340 3. Josam, Model 71700.
Hose valve	Heavy-duty bronze hydrant, with composition disc, handwheel, cap and chain. Sizes 1-1/2-inch and 2-1/2 inch: 1. Murdock 2. James Jones
Hose valve	Size 1-inch, without cap and chain: 1. Murdock 2. James Jones

2.8 WALL-MOUNTED HOSE RACKS

- A. The Contractor shall provide wall-mounted hose racks at locations indicated. Racks shall be all welded steel construction, of minimum 8-gage sheet steel, hot-dip galvanized after fabrication, and shall have a capacity to hold 100 feet of 3/4-inch or 1-1/2-inch hose. Where racks are located in the open, they shall be supported from two 2- by 2- by 1/4-inch galvanized steel angle posts set in a concrete base or as indicated.

2.9 HOSES AND NOZZLES

- A. The Contractor shall furnish a 75 foot length of hose in the size indicated on the Drawings for each hose rack shown on the Drawings
- B. Each length of hose shall be provided with male and female Cam & Grove fittings and nozzle. Hoses shall be non-collapsible seamless extruded rubber designed for a working pressure of at least 200 psi.
- C. Nozzles shall be capable of complete shut-off and shall produce a solid straight stream and up to a 90-degree conical fog. Nozzle material shall be polished brass. Nozzles shall have rubber bumpers.
- D. Nozzle Manufacturers, or Equal:
1. W. D. Allen Mfg. Co., Illinois.
 2. Fire-End and Crocker Corp., New York.

3. Halprin Supply Co., Illinois.
4. Western Fire Equipment Co., California.

2.10 FOAM CONTROL SPRAY NOZZLES

A. General:

1. Provide easy flush nozzles with discharges of 2.0 gpm at 10 psi gauge and spray angle of 120° to 130°. Spray nozzles shall be structurally suitable for pressure up to 200 psi.
2. Spray shall be flat, heavy sheet fan with uniform distribution. Fan width at the water surface shall not be less than 6.5 feet at 10 psi.
3. Spray nozzles shall be leaded bronze or brass. Provide neoprene rubber replaceable spray deflector.

B. Manufacturers, or equal:

1. Spraying Systems Co, Foam Control Nozzle, Series 22561
2. Lechler, Easy Flush Foam Control Nozzle, Series 564

2.11 SCUM MOVEMENT SPRAY NOZZLES

A. General:

1. Provide 15 degree spray angle flat spray type nozzles with discharges of 1.9 to 2.0 gpm at 10 psi gauge. Each spray nozzle shall be provided with an adjustable ball fitting. Ball fittings shall have a 3.8" male inlet and 3.8" female outlet. All materials shall be Type 303 SST.

B. Manufacturers, or equal

1. Spraying Systems Co., Veejet Style H-U
2. Lechler, Series 632

2.12 FULL CONE SPRAY NOZZLES

A. General:

1. Provide full cone flat spray type nozzles with discharge of 2.15 to 2.2 gpm at 10 psi gauge. Each spray nozzle shall be provided with an adjustable ball fitting. Ball fittings shall have a 3.8" male inlet and 3.8" female outlet. All materials shall be Type 303 SST.

B. Manufacturers, or equal

1. Spraying Systems Co., Fulljet Syle HH
2. Lechler, Series 460

2.13 LIFE RINGS AND LIFE RING ENCLOSURES

- A. Life rings shall be provided at the Primary Clarifier as indicated on the Drawings. Life rings shall be 30" diameter Coast Guard approved ring provided with at least 90' of rope.
- B. Life rings shall be provided with fiberglass enclosures designed for outdoor storage, mounted on the deck as indicated on the Drawings and as directed by the manufacturer. Enclosures shall be non-locking "T-Handle" type in safety yellow color.
- C. Manufacturer of Equal
 - 1. Cheyenne Inc., Model LRH-C

PART 3 EXECUTION

3.1 PREPARATION

- A. The Contractor shall coordinate roughing-in with provisions for wall-and floor sleeves, pipe inserts, cutting of roof and floor penetrations so that drain lines will have the required invert elevations and slopes.

3.2 OPENINGS

- A. New Construction: The Contractor shall provide all necessary openings in walls, floors, and roofs for the passage of piping and plumbing equipment within and into the buildings. All openings shall be as indicated on the Contract Drawings or as required to provide passage for the plumbing work.
- B. Existing Construction:
 - 1. The Contractor shall provide all opening required in the existing construction walls, floors, and roofs for the passage of piping and plumbing equipment. All openings shall be as indicated or required for passage.
 - 2. All openings shall be cut in a neat and orderly manner, minimizing damage to existing structures. Patching of openings shall match existing construction.
 - 3. The Contractor shall be responsible for hangers and supporting members installed in existing masonry or structural steel as required for the proper completion of the Work.

3.3 INSTALLATION AND APPLICATION

- A. The Contractor shall provide all plumbing specialties in accordance with manufacturer's printed instructions.
- B. All pipe shall be arranged in a neat and orderly manner to occupy the minimum amount of space and so that the pipe will not obstruct passageways and movement of building occupants or interfere with normal operation and maintenance of any equipment.

- C. All pipe shall be carefully placed and properly sloped and shall be neatly and firmly supported by hangers or supports.
- D. All piping in buildings shall be as close to the ceilings or walls as possible, unless indicated otherwise.
- E. Screwed joints shall be made with joint compound and be tight and leakproof. A sufficient number of brass to ferrous metal seat unions shall be placed in lines so that any pipe, valve or piece of equipment may be easily disconnected.
- F. All drainage and sanitary lines shall be properly run, trapped, and be vented to conform to Code requirements. All changes in direction shall be made with "Y" branch fittings and shall be of the same size as the pipe. Changes in pipe size shall be made with reducing fittings. Minimum depth of cover shall be 3 feet.
- G. Horizontal soil, drain and waste pipes shall be given a slope of at least 1/4-inch per foot, unless indicated otherwise.
- H. Floor drains and cleanouts shall be installed so the tops of the drains are flush with the finished floor.

3.4 TESTING

- A. General: Contractor shall make such tests as are required by the local ordinances and codes in the presence of a local governing authority inspector to show that all piping is tight, leak free and satisfactory, and shall also perform such tests as the Engineer may direct to ensure that all fixtures and equipment operate properly. The Contractor shall pay all costs in making such tests and the costs of making all changes or repairs until the Work is acceptable to the governing authorities.
- B. Testing of piping shall conform to the requirements of Section 02640 – Pipeline Testing and Disinfection.

3.5 EQUIPMENT - DAMAGE AND REMOVAL

- A. The Contractor's operations shall be carried out in such a manner as to guard against damage to those portions of the structure and equipment which are to remain in the finished work. Any damage caused by the Contractor or Subcontractor through their operations, shall be repaired by the Contractor to the satisfaction of the Engineer and at no additional cost to the Owner.

3.6 DISINFECTION

- A. After potable water supply lines are tested, they shall be disinfected by introducing into the line HTH solution, liquid chlorine, or chlorine solution of sufficient strength. Then the line shall be filled with water and maintained under not less than 10 pounds per square inch pressure, for not less than 48 hours, during which period all valves on the lines shall be opened and closed several times, after which it shall be flushed clean, and then tested by the Contractor. This procedure shall be repeated as often as necessary until the line is pronounced safe for use by the Owner. No cross connection between the water mains and any pipe not yet disinfected will be permitted.

- B. Disinfection of piping and fixtures shall conform to the requirements of Section 02640 – Pipeline Testing and Disinfection.

END OF SECTION

SECTION 15870 – FIBERGLASS REINFORCED PLASTIC (FRP) DUCTWORK

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. General: The CONTRACTOR shall furnish all labor, equipment, materials, tools, supplies, fittings, and appurtenances required for the design, fabrication, and installation of fiberglass reinforced plastic (FRP) ductwork including fittings, dampers, supports, and accessories as shown and as specified herein, in accordance with the requirements of the Contract Documents.
- B. The items specified under this Section shall be furnished by manufacturers having experience in the manufacture of similar products and having a record of successful installations.
- C. All FRP ductwork shall be manufactured of material suitable for the gases and chemicals specified and shall be certified for such use on the shop drawings.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Commercial Standards:
 - 1. ASTM C 581 Practice for Determining Chemical Resistance of Thermosetting Resins Used in Glass Fiber Reinforced Structures, Intended for Liquid Service.
 - 2. ASTM D 638 Test Method for Tensile Properties of Plastics.
 - 3. ASTM D 790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
 - 4. ASTM D 883 Definitions of Terms Relating to Plastics.
 - 5. ASTM D 2563 Recommended Practice for Classifying Visual Defects in Glass-Reinforced Plastic Laminate Parts.
 - 6. ASTM D 2583 Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor.
 - 7. ASTM D 2584 Test Method for Ignition Loss of Cured Reinforced Resins.
 - 8. NBS PS 15-69 Voluntary Product Standard, "Custom Contact-Molded Reinforced Polyester Chemical-Resistant Process Equipment."
 - 9. When two or more of the above regulations are applicable, the more stringent requirement shall be met.

1.3 CONTRACTOR SUBMITTALS

- A. General: CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished this Section and in referenced Sections.
- B. Shop Drawings and Samples: Shop drawings and samples shall be submitted in accordance with the requirements of Section 01330 Submittal Procedures.
 - 1. Drawings showing details of construction of the ductwork including the following:
 - a. All minimum laminate thicknesses.
 - b. All laminate ply sequences.
 - c. Location and size of all stiffeners.
 - d. Construction details for all joints, stiffeners, penetrations, support attachments, flanges, turning vanes, or any other assembly.
 - 2. Drawings showing all fittings, dampers, duct support locations, types, and details; wind and seismic brace locations, types, and details; and other appurtenances.
- C. O & M Manuals: The CONTRACTOR shall provide operators and maintenance data for all equipment furnished for the project in accordance with Section 01730, Operation and Maintenance Data.
- D. Tools: Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the WORK hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

1.4 QUALITY ASSURANCE

- A. CONTRACTOR shall submit the following:
 - 1. MANUFACTURER's Certificate of Proper Installation
 - 2. Functional Test Certification
 - 3. Factory performance test reports
 - 4. Special shipping, storage and protection, and handling instructions
 - 5. MANUFACTURER's printed installation instructions
 - 6. List of suggested spare parts to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance.
 - 7. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.
 - 8. The FRP ductwork supplier shall provide certification for the following:

- a. The resin used has been tested in accordance with ASTM C581 and that the resin is compatible with an environment consisting of air, hydrogen sulfide gas, methane, various aromatic hydrocarbon vapors, droplets of salt water, and droplets of water containing sodium hypochlorite, sodium hydroxide, and sulfuric acid.
- b. The fiberglass used has a flame spread rating of 25 or less and as measured in accordance with NFPA No. 255, Standard Method of Test for Surface Burning Characteristics of Building Materials.
- c. Samples: Samples of the manufacturer's standard gel coat colors shall be submitted to the ENGINEER for color selection.

B. Warranty

1. A written suppliers warranty shall be provided for the equipment specified in this section as required in Section 01785 Warranties and Bonds.

PART 2 PRODUCTS

2.1 DUCTWORK DESIGN

- A. General: All FRP exposed, concrete encased and buried air ducts, plenums and exhaust stacks shall be designed as specified herein.
- B. Wall Thickness: Minimum wall thickness shall be 1/4-inch. Additional thickness may be required to meet deflection, specific loading requirements or duct pressure operating requirements.
- C. Dimensions: The duct and plenum dimensions indicated on the drawings are net inside, indicating the clear space required inside the duct or plenum after lining is installed. Actual duct dimensions shall be increased to accommodate lining material, where lining is required.
 1. Design calculations for these conditions shall be furnished with the shop drawings.
- D. Deflection for exposed installation: The ductwork shall be designed to meet the following specification with respect to supports. Supports shall be designed and installed furnished by the Contractor at no extra cost. Maximum deflection of a side on a rectangular duct shall not exceed 2 percent of the width of the side at a test vacuum pressure of 6 inch W.C. Maximum deflection of round duct shall not exceed 2 percent of the duct diameter under an imposed hoop (point) loading of 550 lbs. After installation, horizontal rectangular ducting shall not sag in excess of 2 percent of the shortest side as measured from a straight and true centerline of the duct to the actual midpoint of the installed duct. Similarly, maximum sag of horizontally installed round duct shall not exceed 2 percent of the diameter. Duct supports shall be designed and installed such that the maximum deflections and sags specified are not exceeded. Any internal support components of the duct work shall not increase the system pressure drop.
- E. Duct Supports:
 1. Duct supports designed for static, dynamic, wind, and seismic loads. Supports and anchorage of all equipment shall be designed in Drawing GS-1.

2. Calculations for supports shall be signed by an engineer registered in the State of California.
 3. CONTRACTOR shall note that the pipe support details in the DRAWINGS are not designed to resist seismic forces. CONTRACTOR shall design and install additional supports as needed to resist the seismic condition listed above. Design calculations shall be submitted to the ENGINEER in accordance with Section 01330, Submittal Procedures.
- F. Expansion and Contraction: Expansion joints shall be provided as needed. The minimum expansion and contraction provided for in the expansion joint specified elsewhere in this section shall be increased as needed due to calculated thermal movement. Expansion and contraction shall be determined on the basis of a temperature differential of 90°F. Thermal coefficients shall be determined by test for the laminate used, and the maximum expansion and contraction for the expansion joints.

2.2 MATERIALS OF CONSTRUCTION

- A. Resin: The duct shall be constructed using a high quality corrosion-resistant resin such as Hetron 992, Dow Derakane 411, or ICI America's Atlac 580. Selection of the proper resin for the chemical environment shall be based on the corrosion guides and previous experience of the resin manufacturer. The resin shall not contain any fillers except as required for viscosity control.
- B. Reinforcing Material: The reinforcing material shall be a commercial grade of glass fiber having a suitable bond between glass reinforcement and resin, such as manufactured by Owens-Corning, or Johns-Manville.

2.3 CONSTRUCTION

- A. General: Ducts shall be manufactured to the sizes and tolerances of National Bureau of Standards Voluntary Product Standard PS 15-69 except as modified in these specifications.
 1. Physical Properties of Laminate: The laminate shall, in all cases, have the following physical properties:

2.	Physical Properties (at 73°F)	ASTM Test	Units	Value
3.	Minimum Ultim. Tensile Strength 12,500	D638	psi	
4.	Minimum Flexural Strength 19,000	D790	psi	
5.	Minimum Flexural Modulus of Elasticity (tangent) 800,000	D790	psi	
- B. Laminate Construction: The laminate shall consist of a corrosion liner, a structural laminate, and an exterior layer.
 1. Corrosion Liner: The inner surface of all laminates shall be a resin-rich C-glass veil and E-glass mat with a total thickness of 0.050 inch. The corrosion liner shall be applied in not less than two layers.

2. Structural Laminate: The corrosion liner shall be followed by a structural laminate of either hand-layup or filament wound construction. Minimum allowable structural laminate thickness shall be the minimum wall thickness specified in this section, less the corrosion liner thickness.
3. Exterior Layer: The exterior layer shall be resin-rich and reinforced with one layer of C-glass surfacing veil. The exterior layer shall be finished with a gel coat consisting of polyester resin, a pigment for color, and an ultra-violet light inhibitor. Minimum thickness of the exterior layer shall be 0.020 inch. The pigment and ultraviolet light inhibitor can be excluded in the encased and buried ducts.

C. Flanges: Flanges shall conform to the specifications in PS 15-69.

1. Turning Vanes: Smooth bends or internal turning vanes shall be provided at elbows, tees, and other points in the duct system where air flow changes direction. Square-turn elbows shall be fitted with shop-fabricated double-blade turning vanes mounted inside rails. Construction shall be of the same material as the ductwork and rigid enough to prevent vibration at high air flow.
2. Drainage: Ducting shall be specifically designed to facilitate water drainage; raised lips at duct joints will not be accepted.

2.4 WORKMANSHIP

- A. Visual Defects: ASTM D2563 shall be used for quality control of both filament-wound and hand lay-up construction. Acceptance levels shall be as follows:

Process Surface:	Defects:
Blisters	None
Burned Areas	None
Chips	None
Cracks	None
Crazing	None
Dry Spots	None
Entrapped Air	None at surface. If in laminate 1/16-in dia max and 5/sq max
Exposed Glass	None
Exposed Cut Edges	None
Foreign Matter	None
Pits ft.	Max 1/8-in dia X 1/32-in deep, max 10/sq
Scratches	None (coated)

Surface Porosity	None
Wrinkles	Max deviation 10 percent of wall thickness.
Sharp Discontinuity	None
Non-Process Surface:	Defects:
Blisters	Max 1/4-in X dia 1/16-in high.
Burned Areas	None
Chips	Max 1/4-in with max thickness of 20 percent of wall.
Cracks	None
Crazing	Slight
Dry Spots	Max 2 sq in/sq ft
Entrapped Air area.	1/8-in dia max; no more than 3 percent of area.
Exposed Glass	None
Exposed Cut Edges	None
Foreign Matter	None if it affects the properties of laminate.
Pits	Max 1/8-in dia X 1/16-in deep.
Scratches	None (coated)
Surface Porosity	None
Wrinkles	Max deviation 20 percent of wall thickness, but not exceed 1/8-in.
Sharp Discontinuity	None

B. If the area fails to meet the requirements of entrapped air or voids in less than 40 percent of the total surface, those areas may be repaired and reinspected. If the defective areas exceed 40 percent of the total surface, the entire vessel shall be rejected.

C. Shop Inspection: The ENGINEER shall be permitted access to the plant area at all times during fabrication and shall be notified one week prior to the estimated date of tests and/or inspections. Final inspection and approval shall be obtained prior to shipment unless written waiver is obtained. The shop inspection of the equipment shall include the following:

1. Check for compliance with drawing dimensions and adherence to construction standards.
2. An acetone wipe test to check surface cure. No surface tackiness is permitted.

3. A Barcol hardness test; at least 90 percent of manufacturer's specified hardness must be attained.
4. Examination of laminated (nozzle) cutouts.
5. A hydrotest of at least 24 hours duration to check for leaks.

2.5 DAMPERS

- A. Control dampers shall be the locking quadrant type and shall be constructed of a vinyl ester resin fiberglass. The thickness of the flange mount channel frame and blade shall be recommended by the manufacturer. Damper components shall be epoxied together and/or held in place with monel fasteners. Blade shall be stiffened as required. Frame shall be equipped with full circumference blade stop. Blade shall have a full circumference viton seal.
- B. A mechanism for positively locking the damper in position shall be provided. Each control damper shall be furnished with a hand lever or chain operator whenever it is more than six feet above the surrounding ground elevation.
- C. Chains shall be aluminum not less than 1/4-inch nominal size and shall be looped to extend within 4 feet above the operating level. Twist chains or wire chains will not be accepted. Chain sprocket wheels shall be of the same material as the chain.
- D. Levers, chains, and chain sprocket wheels may be constructed of aluminum. It is the manufacturer's responsibility to furnish all associated parts of the damper of sufficient strength to support the chain.
- E. Dampers with chain operators shall be furnished with an indicator to show the open and closed position. The indicator shall be clearly visible from the operating level.
- F. All control dampers shall be able to operate in a partially closed position at a differential pressure of 4-inch w.c.
- G. All control dampers shall be furnished with seals to reduce leakage. Permissible leakages shall not be in excess of those in the published literature of the named manufacturers.
- H. Manufacturer: All dampers shall be manufactured by Swartwout, Viron International or equal.

2.6 DUCT SUPPORTS

- A. Duct supports shall be designed to allow a maximum deflection of ½ " deflection at midspan. Maximum spacing between supports shall not exceed 20 feet. Duct supports shall be provided at all changes of direction.
- B. Point loads from supports are not acceptable. Protective sleeves that have 120° of contact and a minimum of 16" long or a minimum support width of 2" for 12" and 1 ¾" for 8" shall be utilized.
- C. All supports will be properly anchored to positively restrain the movement of the duct.
- D. All support materials utilized shall be FRP, PVC, or galvanized.

2.7 BIRDScreens AND INLET GRILLES

- A. All air intakes, except in the belt filter press hoods, shall be provided with FRP inlet grilles and bird screen of No. 8 mesh not less than 12 gage 316 stainless steel wire. Each bird screen shall be provided with a Type 316 stainless steel frame. Screens and grilles shall be securely held in place but shall be conveniently removable.

2.8 METAL ACCESSORIES

- A. All metal encased in or attached to any fiberglass item shall be Type 316 SS.

2.9 PROTECTIVE COATING

- A. Fiberglass ductwork shall not be painted. The color shall be impregnated in the exterior layer. Color shall be selected by the District.

2.10 MANUFACTURERS

- A. MANUFACTURER's Experience: The materials and equipment covered by this specification are intended to be standard materials and equipment of demonstrated successful performance and supplied by a manufacturer who has been actively engaged in the supply of similarly sized FRP ducting for a minimum of 10 years. Equipment shall be designed and constructed in accordance with the highest standards of the industry and shall be installed in accordance with the MANUFACTURER's recommendations and the Contract Documents.
- B. Manufacturers or Equal:
 - 1. Harrington Industrial Plastics, Inc.
 - 2. Ceilcote Company
 - 3. Beverly Pacific

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. A complete set of MANUFACTURER's instructions covering storage, installation, operation, lubrication, and maintenance shall be furnished to the OWNER no later than the date the equipment is shipped. Care during storage and procedures for installation, lubrication, and startup of the equipment and motors shall be in strict conformance with the MANUFACTURER's instructions.

3.2 GENERAL

- A. Installation shall be in strict accordance with the manufacturer's instructions and recommendations.
- B. No ductwork shall be fabricated or installed until it has been carefully coordinated with equipment specified elsewhere. Duct dimensions shown are "net" inside clear.

3.3 INSTALLATION

- A. Duct hangers and supports shall be fabricated out of materials as shown on the Drawings. Attachment of hangers or supports to fiberglass ducting with screws is unacceptable.
- B. All nuts, bolts and washers shall be type 316 stainless steel. Washers shall be used under all nuts and bolt heads.
- C. Gaskets shall be 1/4-inch thick full-face made of closed cell neoprene, sponge, silicone coated. Gaskets shall have a shore A hardness of not less than 50.
- D. Field joints shall be 100 percent sanded just prior to wet lay up (inside and outside). Field joints shall be made by wrapping with strips of reinforcement saturated with resins. The width of the first layer shall be 2 inches minimum and each layer shall increase in width uniformly until at least the thickness of the heaviest section being joined is achieved. Total minimum width of joint shall be 9 inches. Mating edges shall be coated with resin to cover all cut edges, and all voids shall be filled with a resin putty mix. The inside surface of joints shall be sealed with a wax resin mix where joints are not accessible. Where internal joints are accessible, they shall be laid up with two 1-1/2 ounce mats then covered with a C-glass veil and sealed with a wax resin mix. All field joints shall meet or exceed duct section properties. Color match adjacent ducts shall be as close as possible.

3.4 EXPANSION JOINTS:

- A. Expansion joints shall be one piece bellows type made of 1/4-inch thick material with two-ply polypropylene reinforcement with a Hypalon exterior layer and butyl interior layer. The expansion joint shall be designed to span a 1 1/2-inch gap and to allow for widening of that gap to 3 inches, unless noted otherwise on the drawings or as needed by calculation.
- B. Flexible connectors shall be made with flanged materials with two-ply polypropylene reinforcement with a Hypalon exterior layer and butyl interior layer or approved equal. A minimum clearance of 3 inches shall be maintained between the ends of duct or between the fan and end of duct. Flexible connectors shall be furnished at each side of all centrifugal fan connections to a duct.
- C. Expansion joints and flexible connectors between flangeless ducts and fan inlets shall be attached with two stainless steel bands.
- D. A watertight and airtight seal shall be provided at all joints.

END OF SECTION

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SECTION 15954 – HVAC SYSTEM BALANCING

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. This section includes HVAC system balance, as defined by AABC or NEBB, which constitute the process of testing, adjusting, and balancing each system component so that the entire system produces the results for which it was designed.
- B. Work shall include the proper use of instruments, evaluation of readings, adjusting the systems to design conditions, full implementation of all AABC/NEBB test report forms, and providing unbiased opinions of the deficiencies encountered and proposing corrective actions.
- C. Definitions:
 - 1. Certification of Personnel is the action of determining, verifying, or attesting in writing to the qualifications of an individual.
 - 2. Qualifications are the characteristics or abilities gained through training, experience, or both, that enables an individual to perform his work properly.
 - 3. Qualified Procedures are the test procedures developed and published by AABC, NEBB, AMCA, ASHRAE, or other nationally recognized Testing, Adjusting, and Balancing (TAB) Association or Agency.
 - 4. Supervision means that tests performed under this contract in any of TAB categories stated herein shall be under the direction and supervision of a TAB Level III employee on the Job Site.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

AABC	National Standards for Total System Balance: Air Distribution, Hydronic systems, Air Pollution, Sound and Vibration
AMCA Publication No. 203	A Guide to the Measurement of Fan System Performance in the Field
ASHRAE	HVAC Applications Handbook
ADA Test Code No. 1062	Equipment Test Code
ANSI A1.4	Specification for Sound Level Meters
ANSI S1.11	Specification for Octave, Half-Octave, and Third-Octave Band Filter Sets
NEBB	Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems

1.3 CONTRACTOR SUBMITTALS

- A. General: CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished this Section and in referenced Sections.
- B. Shop Drawings and Samples: Shop drawings and samples shall be submitted in accordance with the requirements of Section 01330 – Submittal Procedures.
- C. Testing Reports: CONTRACTOR shall perform equipment and systems tests, compile test data, and submit reports the ENGINEER. Specific procedures used in tests shall be performed in strict accordance with AABC or NEBB requirements and shall be included in the test report. CONTRACTOR shall identify equipment, drawing and identification code. CONTRACTOR shall submit data on printed report forms published by AABC or NEBB. All reports shall be certified by a TAB Level III Engineer. Each individual reporting form submitted must bear the signature and TAB Level of the data recording engineer.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION

3.1 TESTING

- A. Obtain air and water balancing and vibration and noise criteria testing performed by an independent air and water balance and testing agency currently certified by the AABC or NEBB. The testing agency shall be a specialist in the balancing and testing of mechanical systems.

3.2 PERSONNEL QUALIFICATIONS

- A. A TAB personnel qualification and certification program, meeting the following requirements, shall be maintained by the CONTRACTOR.
 - 1. The CONTRACTOR shall establish a written practice for the control and administration of TAB personnel training, examination, and certification.
 - 2. The CONTRACTOR's written practice shall include a written examination for each personnel TAB level.
- B. There shall be 3 levels of qualifying TAB personnel for each Tab category hereinafter listed:
 - 1. TAB Level I:
 - a. A TAB Level I individual shall be a high school graduate and shall have sufficient training and experience to perform the necessary tests in the TAB Category for which he is certified. A TAB Level I individual shall take test data and shall be responsible to a TAB Level II or TAB Level III Engineer in the applicable TAB Category.
 - 2. TAB Level II:
 - a. A TAB Level II individual shall be (1) a graduate of a 4-year accredited engineering college or university, and shall have 2 years of experience in engineering, or equivalent in manufacturing, construction, and installation

activities, or (2) be a high school graduate, having 4 years of experience in engineering activities or equivalent. In either case, 2 years of this experience shall be in TAB testing and procedures.

- b. A TAB Level II individual shall direct and carry out tests in the category for which he is certified. He must also be able to set up and calibrate instruments, interpret test results, modify procedures as necessary, analyze data, and record the test results on appropriate forms.

3. TAB Level III:

- a. A TAB Level III individual shall be (1) a graduate of a 4 year accredited engineering or science college or university, plus 5 years of experience in engineering, or equivalent manufacturing, construction, and installation activities, or (2) be a high school graduate, 10 years of experience in engineering, or equivalent manufacturing, construction, and installation activities. In either case, 2 years of this experience shall be in TAB testing and procedures.
- b. A TAB Level III Engineer shall establish test procedures, designate test methods and procedures, and interpret test results. He shall be capable of evaluating the results, not only in terms of existing procedures, but also shall possess sufficient practical background in applicable HVAC technology to assist in establishing test procedures when none are otherwise available. He shall be responsible for conducting examinations of TAB Level I and TAB Level II personnel.

C. TAB personnel shall be qualified and certified in the following generic TAB categories:

- 1. Air Systems and Associated Equipment.
- 2. Hydronic Systems and Associated Equipment.
- 3. Sound.
- 4. Vibration.

D. Certification requirements of all levels of TAB test personnel shall be performed by the contractor. Certifications shall indicate the category and level of qualification in that category. Written statements verifying individual qualifications shall be available for review.

3.3 INSTRUMENTS

- A. Instruments used in testing mechanical systems and equipment shall be as recommended by the AABC, NEBB, AMCA, or ASHRAE. Test instruments used shall be initially and periodically checked thereafter to verify their calibration accuracy as described in AABC or NEBB procedures. Provide calibration verification of each test instrument with each test report.
- B. Test equipment shall be furnished by the CONTRACTOR and shall remain his property.

3.4 GENERAL PROCEDURES

- A. Systems and equipment as listed in the Specifications shall be tested and balanced in accordance with qualified procedures from the AABC or NEBB Standards.
- B. Procedures for each system test and equipment test shall be maintained on file by the contractor and shall be readily available to the Engineer if requested.

- C. Procedures used in tests shall be included in the submitted report.
- D. TAB contractor shall coordinate with the controls contractor for setting and/or positioning of control devices pertinent to facilitating testing and adjustment of all mechanical systems.

3.5 PRELIMINARY PROCEDURES

- A. Do all initial planning, including procurement of all available data, study of all systems, instrument selection and calibration, assembling all requisite report forms, study of construction documents and recording pertinent data on report forms, and performing all calculations possible.
- B. Inspect systems and equipment utilizing appropriate standards checklists to assure construction is complete and ready for balancing.
- C. Confirm that equipment installed matches data on report forms, including manufacturer, model, type, size, capacity, motor horsepower, rpm, etc.
- D. Maintain quality control during the execution of work through final completion.

3.6 AIR SYSTEM PROCEDURES

- A. Follow appropriate AABC or NEBB procedures for testing and balancing supply, return and exhaust air systems and systems with economizers and other energy conservation features where included as part of the Project. Balance flows to 5 percent of specified values.
- B. Specific systems shall include, but not necessarily be limited to: single duct constant or variable volume systems; pressure dependent, independent, or bypass variable volume systems; heating/ventilating systems; associated return air systems, general exhaust systems, and all special exhaust systems such as fume/particle removal, and smoke control/containment systems.
- C. Conduct tests for central air handling distribution systems at design air flow with simulated change out filter resistance.
- D. After each air system is balanced, indicate each damper set position with a fully visible, painted red or similar, permanent mark.
- E. Corrective measures, if required, shall conform to requirements of contract documents.

3.7 REPORT FORMS

- A. Report forms, as they relate to the specific Project, shall be fully implemented, including a sealed certification. Report forms shall include, but not be limited to: gas fired heating apparatus, fans, duct systems, air outlets, and instrument calibration.
- B. Report forms shall be standard forms as published by AABC or NEBB.

3.8 RETESTING

- A. During the period following completion of a specific test, and within the Project time frame, the ENGINEER may, at his discretion, request a recheck or resetting of any outlet, supply air fan, or exhaust fan as originally covered in the Scope of Work of this

Specification. Retesting procedures, personnel qualifications, and report requirements shall be the same as the original requirements.

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**SECTION 16000
REQUIREMENTS FOR ELECTRICAL WORK**

PART 1 GENERAL

1.1 DESCRIPTION

- A. This section specifies electrical work including labor, electrical material, equipment, and installation and testing requirements for complete operating system. Electrical work shall also include demolition and or relocation and modifications of existing electrical equipment as shown and specified in these specifications. All equipment requiring power and or control shall include equipment furnished under this section and other sections of the specifications. The electrical drawings included in this project document are diagrammatic only and functional in nature and do not specify exact locations of equipment or equipment terminations. Furnish and install required junction boxes, pull boxes, condulets etc such that no conduit runs shall have more than three 90-degree bends.

1.2 QUALITY ASSURANCE

- A. References: This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
- B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, whether or not the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI A58.1	Minimum Design Loads for Building and Other Structures
IEEE 81	Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
IEEE C57.12.01	General Requirements for Dry-Type Distribution and Power Transformers
NEMA 250	Enclosures for Electrical Equipment (1000 Volt Maximum)
NEMA ICS 1	General Standards for Industrial Controls and Systems
NEMA ICS 2	Industrial Control Devices, Controllers, and Assemblies

Reference	Title
NEMA ICS 6	Enclosures for Industrial Controls and Systems
NEMA ST20	Dry-Type Transformers for General Application
NEMA WD 1	General Requirements for Wiring Devices
NFPA 70	National Electrical Code (NEC)
CBC	California Building Code and California Electrical Code
UL 50	Enclosures for Electrical Equipment
UL 62	Flexible Cords and Cables
UL 67	Panelboards
UL 489	Molded-Case Circuit Breakers and Circuit Breaker Enclosures
UL 506	Specialty Transformers
UI 508A	Standard for Industrial Control Panel

- C. Identification of Listed Products: Electrical equipment and materials shall be listed by an independent testing laboratory for the purpose for which they are to be used. Three such organizations are Underwriters Laboratories, Inc. (UL), Canadian Standards Association (CSA), and Electrical Testing Laboratories (ETL). The independent testing laboratory shall be acceptable to the inspection authority having jurisdiction.

1.3 SUBMITTALS

- A. The following specific submittal requirements for the switchgear, switchboard, motors, transformers, power distribution panels and starters or VFD's shall be followed:
1. Contractor shall formally place an order with equipment manufacturer within thirty days of the award of the contract. The order shall include all relevant drawings and specs including any addendum items associated with the equipment.
 2. Contractor shall submit shop drawings to the District as soon as possible or within 6 weeks of the order being placed for long lead items such as standby generator.
 3. Contractor shall forward review comments to equipment manufacturer within two days after receipt of the comments by the District.
 4. Contractor shall provide the release for manufacturing to equipment manufacturer within 3 business days of receiving a favorably reviewed submittal and shall provide the District with the shipping date.
 5. Prior to shipment, a factory test of the equipment witnessed by the District shall occur.

B. The following information shall be provided for all electrical equipment and materials in accordance with Section 01300:

1. Verification of fault withstands and interrupting ratings of all applicable power equipment and devices.
2. Interconnection diagrams -The Contractor shall prepare interconnection diagrams depicting all cable requirements together with their actual terminations as specified below.

Interconnection diagrams shall be drawn to reflect actual, physical relationship between equipment and or components as shown on the drawings. The interconnection diagram shall indicate wiring between panels, terminal boxes, remotely mounted devices, and motor starters. The diagrams shall interface with the manufacturer's internal connection diagrams for panels. The diagrams shall indicate the terminations to terminal blocks of field devices at each end of the cable, the number of conductors in the cable, the size of wire, and the number of spare conductors. For each termination, the diagrams shall indicate the terminal number, wire color, and wire number as it appears on the wire marker. All terminal blocks, including spares, shall be indicated on the diagrams. Interconnection diagrams shall be provided for review and approval prior to installation of equipment.

3. Catalog-cuts including technical specifications, application information, ratings, make and model number, and other information required to verify the equipment and/or material meets the requirements of this specification.
4. A copy of this specification section with addenda updates, and all referenced sections with addenda updates, with each paragraph check marked to show specification compliance or marked to show deviations.

1.4 PROJECT/SITE CONDITIONS

- A. General: Unless otherwise specified, equipment and material shall be sized and rated for an ambient temperature of 40 degrees C at an elevation ranging from sea level to 100 feet without exceeding the manufacturer's stated ratings. All outdoor locations shall be considered as corrosive areas. Enclosures for outdoors, unless otherwise noted, shall be NEMA 4X, 316 stainless steel.
- B. Seismic: All electrical equipment and supports shall be braced in accordance with latest California Building Code.
- C. Classified Hazardous locations: The Digester's interior shall be Class 1 Division I hazardous location. All electrical and or devices located in such locations shall be classified and suitable for use in such classified locations. All conduits entering or leaving the hazardous locations shall be provided with "EYS" seals per NEC.

1.5 ELECTRIC SERVICE

Electric service for this facility is existing and fully functional for the entire plant. Any shutdown request shall be made in two weeks advance for approval by the District.

Refer to Section 01140- Work Restrictions for general sequence of work and project constraints. General electrical sequence of work is part of the general sequence and is as shown on the drawings.

PART 2 PRODUCTS

2.1 GENERAL

Equipment and materials shall be new and free from defects. All equipment of the same or similar type shall be of the same manufacturer throughout the work. Standard production materials shall be used wherever possible.

2.2 RACEWAY, FITTINGS, AND SUPPORTS

A. General: Conduit shall be provided for power, control, instrumentation, grounding, lighting, receptacles, and signaling systems.

B. Raceway:

1. All exposed conduit, indoor and outdoor, shall be threaded, PVC-coated galvanized, rigid steel conduit. All conduit accessories such as couplings, elbows, junction boxes etc. shall also be PVC-coated galvanized steel. Minimum size of conduit shall be 3/4 inch. All conduit supports shall be 316 SS. Bushings shall be galvanized, malleable iron with insulating collars. Grounding bushings shall be locking type with a feed through compression lug. Unions shall be galvanized, ferrous alloy type. Threadless fittings are not acceptable. Running threads shall not be used in lieu of conduit nipples. Threaded hubs shall be used to terminate conduits entering boxes. PVC-coated RGS conduit shall be manufactured by Robroy Industries, Perma-Cote Industries, or equal.

If required, for conduit installed internally to the MCC auxiliary enclosure, conduit and accessories may be RGS as manufactured by Allied Tube and Conduit, Appleton, PWC Inc. or equal.

2. Liquidtight, flexible steel conduit shall be formed from spirally wound, galvanized steel strip with successive convolutions securely interlocked and jacketed with liquidtight, plastic cover. Minimum size shall be 3/4 inch. Fittings for liquidtight conduit shall have cadmium-plated, malleable iron body and gland nut with cast-in lug, brass grounding ferrule threaded to engage conduit spiral and O-ring seals around the conduit and box connection and insulated throat. Forty-five and 90-degree fittings shall be used where applicable.
3. Embedded or encased underground conduit shall be Schedule 40, high impact, polyvinyl chloride (PVC). Minimum size shall be 1 inch.
4. Fittings for PVC conduit shall be solvent welded type.

C. Boxes:

1. Boxes for use outdoors and in process areas shall be hot-dip, galvanized cast ferrous alloy type FD with integrally cast-threaded hubs for conduit entry. Boxes larger than FD boxes shall be welded steel and hot-dip galvanized after fabrication. Use PVC-coated boxes where PVC-coated RGS conduits are used.
2. Boxes installed in areas where electrical metallic tubing is specified shall be standard UL approved electrogalvanized sheet steel, 4-inch square or octagon minimum trade size. In this project EMT and related accessories are prohibited.
3. Conduit bodies shall be ferrous alloy type with screw taps for fastening covers. Gaskets shall be made of neoprene.
4. Boxes for hazardous locations as indicated on the drawings shall be suitable for Class 1 Div I hazardous location. They shall be corrosive resistant, high tensile strength malleable iron and with threaded aluminum cover. They shall be manufactured by Crouse-Hinds, Appleton Electric, or equal.

D. Raceway Supports: 316 Stainless steel framing channels shall be used to support groups of conduit. Individual conduit supports shall be one-hole stainless steel malleable iron pipe straps with stainless steel clamp backs and nesting backs where required. Ceiling hangers shall be adjustable, stainless steel rod hangers. Straps or plumbers tape are not acceptable. Hanger rods shall be 1/2-inch all thread stainless steel rod.

E. Concrete Pull Boxes: Provide and install pre-cast concrete pull boxes in locations indicated on the Drawings and as required by NEC and PG&E where they are for PG&E service. Pull boxes shall be:

1. Designed for heavy traffic conditions, with pull box and cover designed for heavy traffic bridge loading H-20
2. Minimum 2 feet by 3 feet by 3 feet depth with 3/4 inch diameter pulling irons located at each end. Concrete material shall be reinforced Class A. Larger size box shall be as shown on the drawings.
3. Provided with engraved "Electrical" or "Instrumentation" or "Telephone" as applicable on the top side of the covers.

F. Ceiling or wall mounted pull boxes: These boxes shall be made of 316 stainless steel materials 10 gauge sheet metal suitable for wall or ceiling mounting. Bottom of boxes shall be hinged with latch. Boxes shall fully secured with SS supports and or straps to resist seismic activities.

2.3 CONDUCTORS, WIRE, AND CABLE

- A. General: Conductors, wires, and cable shall be provided for power, control, lighting, receptacles, instrumentation, grounding and signal circuits. The quantity and size of conductors shall be as specified.
- B. Power and Control Conductors: Power and control conductors shall be single conductor, stranded, annealed copper with 600-volt THWN/THHN polyvinyl chloride (PVC) insulation, Okonite, Okoseal-N; CABLEC; or equal.
- C. Lighting and Receptacle Circuit Conductors: Conductors for lighting and receptacle circuits shall be single conductor, annealed copper with 600-volt THWN/THHN PVC insulation. Conductor sizes No. 10 AWG and larger shall be stranded. No. 12 AWG shall be solid conductor. Minimum conductor size shall be No. 12 AWG. Conductors shall be Okonite, Okoseal-N; CABLEC; or equal.
- D. Grounding Conductors: Grounding conductors shall be as specified in paragraph 16000-2.7 A.
- E. Instrumentation and Signal Cable: Cable for instrumentation and signal circuit shall be twisted shielded pair or triad as specified, No. 16 AWG 7-strand copper with 600-volt PVC insulation, 100 percent aluminum-Mylar tape shield, No. 18 AWG tinned copper drain wire and overall PVC jacket, Okonite, Okoseal-N type P-OS, CABLEC, or equal.
- F. Splicing and Terminating Materials:
1. Connectors: Connectors for stranded conductors shall be tool applied tin-plated copper, compression type of the correct size and UL approved for the application.

Connectors for wire sizes No. 10 AWG and smaller shall be nylon self-insulated, ring tongue or locking-spade terminals. Connectors for wire sizes No. 8 AWG and larger shall be one-hole lugs up to size No. 3/0 AWG and two-hole or four-hole for size 4/0 AWG and larger. Mechanical clamp, dimple, or screw-type connectors are not acceptable.

480-volt motor terminations shall be made using bolt connected lugged connectors and factory engineered kits consisting of heat shrinkable, polymeric insulating material with high dielectric strength mastic sealant.

Termination of solenoid valves, 120-volt motors, and other devices furnished with pigtail leads shall be made using self-insulating, tubular compression connectors.
 2. Terminal Blocks: Terminal blocks shall be provided for external control and power wires size 10 AWG and smaller. Terminal blocks shall be 600 volts, heavy-duty, rated 20 amperes for control and 30 amperes for power.
- G. Wire Markers: Wire markers shall be yellow or white shrink tubing, Thermofit Marker System (TMS) by Raychem Co., Thomas and Betts equivalent, or equal for conductors No. 10 AWG and smaller and locking tab cable markers, W.H. Brady Co., Thomas and Betts, or equal, for conductors No. 8 and larger. Letters and numbers identifying each conductor shall be machine printed in permanent black ink.

2.4 WIRING DEVICES

- A. General: Receptacles, plugs, switches, and appurtenances shall be provided as specified on the drawings. Wiring devices shall be UL approved for the current and voltage specified and shall comply with NEMA WD-1. Receptacles and switches shall be premium, specification grade. GFI type in weather proof cover/box shall be provided for all outdoor receptacles.
- B. Receptacles: Receptacles shall be 20A, 120V, and grounding type. Receptacles for use outdoors and in wet process areas shall be corrosion resistant, GFI type, marine duty with polycarbonate weatherproof lift covers, Hubbell 53CM62/ 53CM21, General Electric, or equal.
- C. Switches: Switches for use outdoors and in wet process areas shall be 20 amp, press-switch type with weatherproof, corrosion-resistant neoprene plate, Hubbell, Arrow-Hart, or equal. Switches located in classified hazardous locations shall be suitable for installation in such locations. They shall be made by Killard Hazloc Series, Appleton, Crouse-Hinds , or equal.

2.5 INDIVIDUAL MOTOR STARTERS

- A. General: Unless otherwise specified, individual motor starters shall be combination type with molded case motor circuit protector, 3-pole, 600-volt AC contactor, and three overload relays, NEMA size 1 minimum. Each motor starter shall be individually enclosed. Starters shall be manufactured by Cutler-Hammer, Allen-Bradley, General Electric, or equal.
- B. Enclosures: The door of the motor starter enclosure shall be interlocked with an externally operated disconnect handle, lockable in the open position. Enclosures shall be NEMA 12 for dry indoor areas and NEMA 4X for outdoor and wet process areas.
- C. Motor Branch Circuit Protection: Molded case motor circuit protectors shall be magnetic only with trip settings adjustable over a range of 700 to 1300 percent of the full load current of the motor served. The motor circuit protector, in conjunction with the starter, shall be rated to interrupt 42,000 amperes (symmetrical) unless otherwise specified.
- D. Overload Relay: Overload relays shall be bimetallic type with separate heaters for each of the three poles. Reset shall be accomplished with a reset pushbutton located on the unit door exterior. Trip setting shall be adjustable from 85 to 115 percent of the motor full load rating.
- E. Control Circuits: Control power transformers, fuses, and control devices shall be provided as specified. Two control transformer primary fuses, rated to interrupt 200,000 amperes at 600 volts, shall be provided on all motor starters. Each motor starter shall be provided with one control circuit secondary fuse rated to interrupt 10,000 amperes at 250 volts and sized at 125 percent of the control circuit full load current. Control circuit shall be 120 V with grounded leg.
- F. Wiring: Conductors shall be switchboard type and rated 90 degrees C above ambient temperature. Conductor shall be identified with tag numbers as specified.

- G. Manual Starters: Manual starters shall be provided as indicated on the drawings. Manual starters shall consist of a horsepower rated quick-make, quick-break toggle mechanism together with one or two overloads as specified. Voltage shall be as specified. Indoor and dry location shall be NEMA 12. For outdoor and wet process area, they shall be NEMA 4X corrosive resistant. For classified hazardous locations, they shall be rated for such locations and shall be manufactured by Square D, General Electric, or equal.

2.6 ELECTRICAL CONTROL DEVICES

A. Control Devices:

1. PUSHBUTTONS: Pushbuttons shall be flush head, 30mm diameter, heavy-duty, industrial, 600 volts, 10 amperes, continuous with NEMA rating to match enclosure types. Pushbutton operators shall be red for stop functions and black for all other functions. Escutcheon plates shall be as specified on the drawings. For field mounted pushbuttons, each stop pushbutton shall be provided with a galvanized steel padlockable mechanism. For hazardous locations, the control stations shall be rated as explosion proof suitable for such locations. They shall be Killark Hazloc Series, Appleton, Crouse-Hinds or equal.
2. Selector Switches: Selector switches shall be heavy-duty, 30mm diameter, industrial type, with NEMA rating to match enclosure type, rated 600-volt, 10-ampere, continuous. Switches shall be provided with contact blocks and number of positions as required performing the specified operations. The escutcheon legend shall be as specified on the drawings.
3. Indicating Lights: Indicating lights shall be 30mm diameter, industrial, heavy-duty, push-to-test, transformer type with LED lamps. Indicating lights shall be NEMA rated to match enclosure type. Color of lens shall be as specified.
4. Control Stations: Unless otherwise specified, control stations shall be NEMA 12 or 13 for dry, indoor locations and NEMA 4X for process areas and outdoor locations, Allen Bradley Bulletin 800H, Crouse-Hinds NCS series, or equal.
5. Security (limit switches). Security switches shall be heavy duty, industrial type with adjustable arm, lever made of stainless steel material. Each switch shall have one normally open and one normally closed contact rated for at least 5A at 120VAC. The switches shall be NEMA 4X, and shall be as manufactured by General Electric, Square D, or equal.
6. Thermostats: Thermostat shall be heavy duty, NEMA 4X, 20A 120V rated with dial and indicator suitable for line connection. They shall be manufactured by Dayton, Honeywell, or equal.

B. Control Relays:

1. Load-Switching Control Relays: Control relays used for switching loads (solenoids, actuators, contactors, motor starter coils, etc.) shall be heavy-duty, machine tool type. Relays that have contacts used for remote interlocking or for which the switching load is not shown shall also be heavy-duty machine tool type.

Contacts shall, as a minimum, be 4-pole and be field interchangeable to either normally open or normally closed. Relay shall be capable of accepting a 4-pole adder.

AC relays shall have NEMA A600 contact ratings and electrical clearances for up to 600 volts. DC relays shall have NEMA P300 contact ratings and electrical clearances of up to 250 volts.

Relays shall be Allen Bradley Bulletin-700, Square D Class 8501, or equal.

2. Logic Level Switching Control Relays: Control relays used for switching solid-state logic and signal circuits shall be Potter Brumfield series KUP, Schrack Series RA, or equal. Relays shall have a minimum of three SPDT, gold-flashed, fine silver contacts rated 3 amps resistive at 120 volts AC or 28 volts DC. Relay shall be plug-in type with heavy-duty, barrier-protected screw terminal sockets and clear polycarbonate dust cover with clip fastener. AC models shall have neon lamp indicator wired in parallel with coil.
3. Timing Relays: Solid state timing relays shall be pulse-count type using a high frequency RC oscillator and integrated circuit counter for timing. Electrolytic capacitors shall not be used in the timing circuits. Time delays from 0.1 seconds to 48 hours shall be available with each timer model adjustable over a 20:1 range. On-delay, off-delay, and single-shot timing models shall be available. Timer shall reset in 0.03 seconds or less. Timer accuracy shall be plus or minus 2.0 percent under normal conditions. The timing relay shall have two NEMA Form-C timed contacts. Solid state timing relays shall be Agastat, STA series, Eagle Signals equivalent, or equal.
4. Intrinsically Safe Relays: These relays shall be suitable for use with 24VDC power source with pilot devices located in hazardous classified locations as defined by NEC Article 500. The relays shall be manufactured by :
 - a. R.K Electronics
 - b. Gem Sensors Division of IMO, Inc
 - c. R. Stalh, Inc.
 - d. Idec
 - e. Equal

Provide each relay with two DPDT contacts each rated for at least 5-amp.

All float switches located in Class 1 Div I hazardous location shall be provided with intrinsically safe relays located in control panel or where specifically shown on the drawings .

2.7 GROUNDING MATERIAL

- A. Cable: Grounding cable shall be concentric stranded, annealed bare copper. Cable size shall be as specified, and shall not be smaller than #4/0 AWG.
- B. Ground Rods: Ground rods shall be copper-covered steel, 3/4-inch diameter, and 10 feet long. Rods shall have threaded type, removable caps so that extension rods of the same

diameter and length may be added where necessary. The rods shall be manufactured by ERICO, Galvan Industries, Inc. or equal.

- C. Compression Connectors: Compression connectors shall be cast copper as manufactured by Thomas and Betts, OZ. Gedney, or equal.
- D. Bolted Connectors: Bolted connectors shall be Burndy, O.Z. Gedney, or equal.
- E. Equipment Grounding: Install a green insulated equipment grounding conductor with each feeder and branch circuit from the power source grounding means to the load equipment or device.

2.8 LIGHTING FIXTURES:

- A. General: Unless otherwise specified, lighting materials, including fixtures, accessories and hardware, shall conform with the requirements specified on the applicable LIGHTSPECS in paragraph 16000-3.08 B. Lighting fixtures shall be provided where specified.

Where recessed fixtures are required, the fixture shall be provided with mounting hardware for the ceiling system specified. Catalog numbers given on the applicable LIGHTSPECS shall not be used for selection of mounting hardware, but only as a reference to the type of fixture required. A concealed latch and hinge mechanism shall be provided to permit access to the lamps and ballasts and for removal and replacement of the diffuser without removing the fixture from ceiling panels. Fixtures recessed in concrete shall have protective coating of bituminous paint.

Fixtures shall be aligned and directed to illuminate an area as specified. Fixtures shall be directly and rigidly mounted on their supporting structures. Unless otherwise specified, conduit system shall not be used to support fixtures. Where brackets or supports for lighting fixtures are welded to steel members, the welded area shall be treated with rust-resistant primer and finish paint.

2.9 DISTRIBUTION EQUIPMENT

- A. Panelboards: Panelboards shall be circuit breaker, dead front type with bus bar construction. Panelboards shall be composed of individually mounted circuit breakers designed to be removed without disturbing other breakers.

Bus shall be tin-plated copper and shall have a current rating as shown on the panel schedules sized in accordance with UL 67. Panel fault withstand rating shall be equal to the interrupting rating of the smallest circuit breaker in the panel.

Panelboards shall be provided with a separate ground bus and a full capacity neutral bus. Neutral bus shall be mounted on insulated standoffs with removable link connector to ground bus. Provide an inside pocket to hold circuit directory. Panelboards shall be Cutler-Hammer, Allen-Bradley, or equal.

For outdoor locations, provide lighting panels with NEMA 4X enclosures with padlockable provisions.

- B. Circuit Breakers: Circuit breakers shall be molded-case type provided for the current ratings and pole configurations specified on the panelboard schedule. Circuit breakers rated 120/208 volts and 120/240 volts AC shall have a minimum interrupting current rating of 22K amperes (symmetrical) at 240 volts AC. Circuit breakers rated 277/480 volts AC shall have a minimum interrupting current rating of 42K amperes (symmetrical) at 480 volts.

Circuit breakers shall be bolt-on type.

Circuit breakers shall be listed in accordance with UL-489 for the service specified. Breakers rated 200A or higher shall be provided with solid-state trip unit with multi-functions.

Load terminals of circuit breakers shall be solderless connectors.

Circuit breakers and panelboards shall be products of the same manufacturer.

- C. Dry-type Transformers: Transformers shall conform to IEEE-C57.12.01 and UL 506. The voltage, frequency, number of phases, and KVA rating shall be as specified. Transformers shall have "Energy Star" label as required by latest California Energy Regulations Title 24. They shall be manufactured by Cutler-Hammer, Square D, General Electric, or equal.

Transformers 15 KVA and above shall have a Class 220 insulation system in accordance with NEMA ST20. Transformers 25 KVA and greater shall be designed not to exceed 80 degrees C temperature rise.

Transformer coils shall be copper windings. Aluminum windings shall not be acceptable. Transformer coils 15 KVA and above shall be impregnated with varnish. Transformer coils 10 KVA and below shall be encapsulated.

Transformers shall have electrically isolated primary and secondary windings. Primary and secondary winding configurations shall be as specified. Provisions shall be made to permit separate grounding of the neutral conductor and the enclosure. Single-phase transformers shall be the four winding type.

Transformers 15 KVA and above shall be provided with two 2-1/2 percent full capacity taps above normal voltage and four 2-1/2 percent full capacity taps below rated voltage on the primary winding.

Terminal compartments shall be sized to permit termination of cables specified. Terminal connections shall be made in the bottom third of the enclosure. The terminals shall be copper and sized for the cable specified.

Transformers rated 15 KVA and smaller shall be provided with weatherproof, non-ventilated enclosures.

Indoor transformers rated greater than 15 KVA shall be provided with drip-proof, ventilated enclosures. Outdoor transformers shall have weatherproof enclosures.

2.10 NAMEPLATES

Nameplates shall be made from laminated phenolic plastic. The nominal size of the nameplates shall be 3/4 inch high by 2 inches long. Nameplates shall have black backgrounds with 1/4-inch white letters. If abbreviations are required because of space limitations, abbreviations shall be submitted to the Construction Manager for approval prior to manufacture. Nameplates shall be fastened using self-tapping stainless steel screws. The use of adhesives will not be permitted on the outside of enclosures.

2.11 LIMIT SWITCHES

Where shown on the drawings, limit switches shall be NEMA 4X, corrosive resistant, rated suitable for monitoring door's opening to trigger two DPDT 5A rated contacts. They shall be heavy duty, industrial type made by Allen-Bradley 800 series, Square D or equal.

2.12 MOTOR CONTROL CENTER

See electrical section 16920 600V Motor Control Center for required modifications and additions.

PART 3 EXECUTION

3.1 GENERAL

Unless otherwise detailed or dimensioned, electrical layout drawings are diagrammatic. Actual conduit installation shall be coordinated with field conditions. Junction boxes and pull boxes with quantity as required shall be furnished and installed. The Contractor shall coordinate the location of electrical material and equipment with the work.

Electrical equipment shall be protected from dust, water, and damage. Core drill walls as required for new conduits penetrating existing walls. Coordinate core drill locations with the District prior to actual work.

3.2 RACEWAY, FITTINGS, AND SUPPORTS

- A. General: The Contractor shall limit the number of directional changes of conduit to a total of not more than 270 degrees in any run between pull boxes. Conduit runs shall be limited to 400 feet, less 100 feet for each 90-degree change in direction.

Signal conduit shall be separated from AC power and control conduits. The minimum separation shall be 12 inches for rigid steel and 24 inches for PVC conduits.

Tag power, signal and control conduits with stainless steel tag fastened to conduit with stainless steel cable. Tags shall be engraved with identification as designated on the single-line diagrams. Tags shall be installed at each conduit termination to an enclosure, MCC, control panel, disconnect, motor j-box, signal transmitter, sensor etc..

Cap each spare conduit as per detail shown on the drawings.

- B. Exposed Conduits: Rigid metallic conduit shall be assembled to provide a continuous ground path. Joints shall be made with standard couplings or threaded unions. Bends and offsets shall be made with a hicky or conduit bending machine or shall be factory preformed bends.

Exposed conduit shall be run on supports spaced not more than 10 feet apart and shall be constructed with runs parallel and perpendicular to walls, structural members, or intersections of vertical planes and ceiling. No conduit shall approach closer than 6 inches to any object operating above 30 degrees C.

Conduit supports shall be secured to concrete walls and ceilings by means of cast-in-place anchors, die cast, rustproof alloy expansion shields, or cast-flush anchors. Wooden plugs, plastic inserts, or gunpowder driven inserts are not acceptable as a base for securing conduit supports.

Liquidtight, flexible steel conduit shall be used for the final connection to equipment, devices, and instruments where flexibility is required.

The length of liquidtight flexible steel conduit shall not exceed the lesser of 15 times the trade diameter of the conduit or 36 inches.

- C. Embedded or Encased Conduit: Conduits constructed in concrete which is in contact with earth shall be separated from earth by at least 3 inches of concrete. Clearances equal to the nominal conduit diameter but not less than 2 inches, shall be maintained between encased or embedded conduits except where conduits cross or terminate.
- D. PVC-coated Rigid Galvanized Steel Conduit: All exposed conduits shall be PVC-coated rigid galvanized steel with matching conduit boxes and accessories.
- E. "Eys" seals: Install "Eys" seals as required per NEC, and as shown on the drawings for hazardous locations and locations as identified on the drawings. Fill the seals with compound recommended by the seal manufacturer.

3.3 CONDUCTORS, WIRE, AND CABLE

- A. General: Raceway construction shall be complete, cleaned, and protected from the weather prior to wire and cable being installed. Pulling wire and cable into conduit shall be completed without damaging or putting undue stress on the cable insulation. Soapstone, Talc, or UL listed pulling compounds are acceptable lubricants for pulling wire and cable. Grease is not acceptable. Nylon pull rope shall be pulled through the conduit immediately after concrete pour.

Each power, control, signal, and instrumentation conductor shall be identified at each terminal to which it is connected utilizing the wire markers specified in paragraph 16000-2.03 G.

600-volt conductors will be color coded as follows:

480 V Power

120/240 Lighting and Receptacles

Phase A – Brown

Phase A – Black

Phase B – Orange
Phase C – Yellow
Neutral – White
Ground – Green

Phase B – Red
Phase C – Blue
Neutral – White
Ground – Green

- B. 600-Volt Conductor and Cable: Slack shall be provided in junction and pull boxes. Slack shall be sufficient to allow cable or conductors to be routed along the walls of the box.

Conductors crossing hinges shall be bundled in groups not exceeding 12 and shall be so arranged that they will be protected from chaffing when the hinged member is moved.

Raceway fill limitations shall be as defined by NEC and the following:

Lighting and receptacle circuits may be together in the same conduit in accordance with derating requirements of the NEC. However, lighting and receptacle circuits shall not be in conduit with other circuits.

Solid wire shall not be lugged nor shall electrical spring connectors be used on any except for solid wires in lighting and receptacle circuits. Lugs and connectors shall be installed with a compression tool.

For submersible pump cable installation, follow the pump manufacturer's recommendations and requirements. Furnish and install 316 stainless steel cable grips required to properly support the cables in addition to 316 stainless steel hooks and heavy duty, non corrosive, fiberglass cable ties as required. Cable grips shall be manufactured by Kellems, Hubbell, or equal.

- C. Signal and Instrumentation Cables: Signal and instrumentation circuits shall be run as individual shield twisted pairs or triads. Triads shall be used wherever three-wire circuits are required. Terminal blocks shall be provided at cable junction for running signal leads and shield drain wires. Each conductor shall be identified at such junctions. Instrumentation cables shall be continuous without any splices.

Shields shall not be used as a ground path.

3.4 WIRING DEVICES

Switches and receptacles for use outdoors and in process areas shall be mounted in "FD" type boxes or PVC-coated boxes in locations specified. Unless otherwise specified, switches shall be mounted 48 inches above the floor. Receptacles shall be mounted 18 inches above the floor in finished areas and 48 inches above the floor in process areas and outdoors unless otherwise specified.

3.5 INDIVIDUAL MOTOR STARTERS

Individual motor starters shall be mounted with the operating mechanism 48 inches above the finished floor unless otherwise specified. The Contractor shall size the overload heater elements to the nameplate full load amperes of the motor served. Motor circuit protectors shall be adjusted to the lowest setting not causing false tripping.

3.6 MISCELLANEOUS CONTROL DEVICES

Control stations shall be mounted 48 inches above the floor unless otherwise specified.

3.7 GROUNDING

Electrical equipment and enclosures, metal surfaces of equipment, and metal structural members shall be grounded. Grounding system shall be provided in compliance with the NEC and as specified on the drawings.

Embedded and buried cable connections shall be made by cast copper compression connectors utilizing diamond or hexagon dies and a hand compression tool for wire sizes 2 AWG and smaller and a hydraulic pump and compression head for wire size 2/0 AWG and larger. Embedded ground cables and fittings shall be securely attached to concrete reinforcing steel with tie wires.

Grounding conductors which extend beyond concrete surfaces for equipment connection shall be extended a sufficient length to reach the final connection point without splicing. Grounding conductors which project from a concrete surface shall be located as close as possible to a corner of the equipment pad, protected by conduit or terminated in a flush grounding plate.

Exposed ground connections shall be made by bolted connectors. Exposed grounding conductors shall be supported by noncorrosive metallic hardware at 4-foot intervals or less.

Grounding conductors entering enclosures shall be bonded together to the enclosure if it is metallic and to metallic raceway within terminating at the enclosure. Metal surfaces shall be cleaned prior to making grounding connections and bonds.

When install ground rods, field verify exact location of existing underground utilities such as water piping, gas piping, electrical conduits or ductbanks, vault or manholes etc prior to installation of the ground rods to avoid damage to the existing underground utilities.

3.8 LIGHTING FIXTURES

- A. General: The location and type of fixtures and receptacles are shown on the drawings. Raceways and wire shall be provided from the fixtures, switches, and receptacles to the lighting panel in accordance with the NEC.

Fixtures labeled to require conductors with a temperature rating exceeding 75 degrees C shall be spliced to circuit conductors in a separately mounted junction box. Fixture shall be connected to junction box using flexible conduit with a temperature rating equal to or greater than that of the fixture.

Labels and marks, except the UL label, shall be removed from exposed parts of the fixtures. Fixtures shall be cleaned when the project is ready for acceptance.

3.9 PANELBOARDS

The contractor shall type in the circuit descriptions on the circuit directory as shown on the final record drawings or panel schedule.

3.10 TESTING

- A. General: Prior to energizing the electrical circuits, the tests shall be performed as specified. Unless otherwise specified, a 500-volt megohmmeter shall be used for resistance measurements.

The measurements of the tests shall be recorded on the specified forms and provided in accordance with paragraph 16000-1.3.

B. Insulation Resistance Measurements:

1. General: General insulation resistance measurements shall be made on conductors and energized parts of electrical equipment. Minimum acceptable values of insulation resistance shall be in accordance with the applicable ICEA, NEMA, or ANSI standards for the equipment or material being tested, unless otherwise specified. The ambient temperature at which insulation resistance is measured shall be recorded on the test form.
2. Conductor and Cable Tests: The phase-to-ground insulation resistance shall be measured for all circuits 120 volts and above except lighting circuits. Measurements may be made with motors and other equipment connected. Insulation resistance measurements shall be recorded and submitted to the Engineer for review and approval. Insulation with resistance of less than 10 megohms is not acceptable.
3. Motor Tests: All motors shall have their insulation resistance measured before they are connected. Motors 50 HP and larger shall have their insulation resistance measured at the time of delivery as well as when they are connected. Insulation resistance values less than 10 megohms are not acceptable.

C. FUNCTIONAL CHECKOUT:

Prior to energization of equipment, the Contractor shall perform a functional checkout of the control circuit. Prior to functional testing, all protective devices shall be adjusted and made operative. Checkout shall consist of energizing each control circuit and operating each control, alarm or malfunction device and each interlock in turn to verify that the specified action occurs. Contractor shall submit a description of his proposed functional test procedures prior to the performance of functional checkout.

The Contractor shall verify that motors are connected to rotate in the correct direction. Verification may be accomplished by momentarily energizing the motor, provided the Contractor confirms that neither the motor nor the driven equipment will be damaged by reverse operation.

D. GROUNDING SYSTEM TESTS:

The Contractor shall test each grounding connection to determine the ground resistance. The grounding test shall be IEEE Standard 81. A plot of ground resistance readings for each isolated ground rod or ground mat shall be provided to the Construction Manager on 8-1/2 x 11 inch size graph paper. The current reference rod shall be driven at least 100

feet from the ground rod or grid under test. The measurements shall be made at 10-foot intervals beginning 25 feet from the test electrode and ending 75 feet from it, in direct line between the ground rod or center of grid and the current reference electrode.

A grounding system that shows greater than 2 ohm resistance for the flat portion of the plotted data shall be considered inadequately grounded. The Contractor shall add additional parallel connected ground rods and/or deeper driven rods until the ground resistance measurements meet the 2 ohm requirement. Ground rods required over that specified will be paid for as extra work. Use of salts, water, or compounds to attain the specified ground resistance is not acceptable.

3.11 DEMOLITION AND SALVAGED EQUIPMENT

Contractor shall be responsible for demolition of the existing electrical equipment and shall removed unused electrical equipment and discard them in proper manner. See section 16025 for additional and specific requirements.

3.12 RECORD DRAWINGS

Record drawings refer to those documents clearly maintained and annotated by the Contractor during construction include record drawings in accordance with these specifications. Contractor shall submit record drawings that reflect as-installed conditions. Drawings do not conform or do not show as installed conditions shall be rejected and shall be resubmitted by the Contractor for no additional cost to the District until acceptance by the Engineer. Markups for deviations and changes shall be on a full size set of drawings.

3.13 SEQUENCE OF WORK

For general project construction sequence, refer to section 01140- Work Restrictions for details. For electrical work, Contractor shall follow Sequence of Work as specified in these specifications. Submit plan for review and approval two weeks in advance. Follow all requirements including traffic controls and barricades to provide a safe area for the pedestrians and plant staff.

END OF SECTION

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SECTION 16025
ELECTRICAL DEMOLITION AND MODIFICATIONS

PART 1 GENERAL

1.1 SCOPE OF WORK

- A. Furnish all labor, materials, and incidentals required to demolish, modify and/or remove the electrical and instrumentation systems and equipment as shown on the Drawings or specified herein. All demolition work shall be performed by licensed electricians. All electrical sources shall be field verified, and shall be de-energized prior to demolition work. Coordinate work with the District in advance to assure minimized interruptions to the existing operations.
- B. Unless specifically noted as being reused, all conduit, wire, boxes, etc. detailed on the Drawings shall be new equipment installed under this Work.
- C. The electrical modifications and removals work shall consist of, but not necessarily be limited to, removal or modifications of existing equipment in the following generalized categories:
 - 1. Modification of motors, motor starters, panels, lights, outlets, PLC cabinet and other devices as indicated on the Drawings.
 - 2. Any electrically powered or controlled equipment indicated as being removed in this Contract and associated electrical appurtenances.
 - 3. Existing electrical equipment or electrical equipment associated with mechanical or process equipment which needs to be removed or relocated due to conflicts with new construction.
 - 4. Electrical control devices, starters, wiring, and other miscellaneous devices associated with equipment that will be modified or reused under this Contract.
 - 5. Instrumentation and control equipment and related conduit and wire associated with equipment being removed under this Contract.
 - 6. All removed electrical copper conductors shall be salvaged and stored in a specific bin to return to the District.

1.2 RELATED WORK

- A. Additional requirements for equipment demolition and salvage are specified in Section 02050 – Demolition

1.3 SUBMITTALS

- A. All submittals shall be in accordance with Specifications.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 EQUIPMENT TO BE REMOVED

- A. Only the major electrical and instrumentation equipment to be removed is shown or noted on the Drawings and failure to detail all equipment exactly shall not relieve the Contractor from the responsibility for its removal as directed by the Engineer. Removal items such as wire, conduit, junction boxes, anchorages, etc. are in general not detailed on the Drawings.
- B. Where removal of electrical, instrumentation, or any other equipment with wired connections is called for in this Work, the work shall include the removal of the associated electrical hardware as specified herein unless noted otherwise.
- C. Unless otherwise noted, all wiring shall be removed from the conduits; boxes and fittings and all exposed conduit shall be removed as shown and or described on the drawings. Unless specifically noted otherwise, concealed conduits shall be cut flush with the floor, wall, or ceiling and plugged with non-shrink grout.
- D. Electrical power, control, or instrumentation equipment, exposed conduit, wiring, etc. rendered inoperative by modifications to existing equipment under these sections or other Divisions of this contract shall be removed unless specifically noted that it is to be abandoned in place.
- E. Not all existing conduits are shown on the Drawings. In general, existing conduits are shown only where they may be reused; or where they potentially affect or may be affected by new work under this Contract; or for providing useful background information to the Contractor regarding the existing electrical installation.
- F. Where existing conduit or wire associated with removed equipment is to be reused, it will be specifically noted on the Drawings or Conduit and Cable Schedules.
- G. No existing conduits, wiring, or electrical appurtenances shall be removed or in any way damaged unless allowed by the provisions of this Section. Any existing conduits or wiring or other electrical appurtenances that are encountered as an obstruction to new construction which are not covered by the provisions of this Specification shall be brought to the attention of the District. Cut concealed conduits flush with surface of existing slab to avoid tripping hazard, and fill properly with non-shrink grout.
- H. Where functions of existing cables or conduits are replaced by new cable or conduits because of additions of new panels, instruments, revision to control strategy, etc., the existing cables and exposed conduits shall be removed unless noted otherwise. Where shown on the drawings, or where terminating in equipment enclosures, concealed conduits shall be retained and marked as spares.
- I. Equipment removed shall not be reused under this contract unless specifically noted on the Drawings or Specifications.

- J. For equipment to be replaced with new equipment, existing power and control wirings shall be carefully tagged, and shall be reused for connections to new equipment. Splice cables in new junction boxes and extended to new location as required.
- K. To minimize disruptions to the existing plant operations, the schedule for modifications and removal of existing equipment shall be coordinated with and approved by the Engineer and District.
- L. Where, if applicable, any existing circuits are disconnected due to abandonment or removal of existing equipment, the remaining motor starters or circuit breakers for these circuits shall be retagged as spares. At motor control centers, the tags shall be laminated nameplates matching the existing ones. In circuit breaker panels, the circuit card or listing shall be changed.
- M. Demolished and removed equipment, conduit, wire, etc., shall become the property of the Contractor unless specifically noted otherwise on the Drawings. Contractor shall be responsible for disposing removed equipment in conformance with the requirements of Section 02050 - Demolition. Where specifically shown on the Drawings, selected electrical equipment shall be protected, removed and turned over to the District per the requirements of Section 02050 - Demolition.

END OF SECTION

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SECTION 16075 ELECTRICAL IDENTIFICATION

PART 1 GENERAL

1.2 SUMMARY

- A. Section Includes: Identification of electrical conductors, raceways and equipment, and electrical equipment signs.
- B. Related Sections:
 - 1. Section 16000 – Requirements for Electrical Work

1.3 REFERENCES

- A. National Electrical Code (NEC):
 - 1. Article 110–22 - Disconnecting Means.
 - 2. Article 210–4 - Multi-wire Branch Circuits.
 - 3. Article 200 - Use and Identification of Grounded Conductors.
 - 4. Article 384 - Switchboards and Panelboards.
 - 5. Article 300 - Wiring Methods.

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. General: Submit Shop Drawings for electrical equipment room layouts, drawn at a minimum at 3/8 inch = 1 foot, scale.
 - 2. Cross Reference: Diagram shall carry a uniform and coordinated set of wire numbers and terminal block numbers to permit cross-referencing between the Contract Document Drawings, the Drawings prepared by the CONTRACTOR, and equipment O&M Manual Drawings.
 - 3. Drawing number cross references and continuation references shall also be provided. Contractor-prepared Drawings shall reference applicable CONTRACTOR Drawings such as P&IDs, control and logic diagrams, interface wiring diagrams, Panel Drawings, etc. Contractor-prepared Drawings shall also reference applicable Drawings provided by equipment manufacturers.
 - 4. On any Drawing prepared for this project, if a wire, circuit, enclosure, panel, or device is continued on another Drawing, the continuation Drawing shall be referenced (and vice-versa). Wherever wires are shown connected to terminals, the Drawings which show the continuation of the circuits on those terminals must be referenced.
 - 5. Interconnection Diagrams: Cables shall not be installed into raceways until the wiring interconnection diagrams are reviewed by the design engineer.
 - 6. Sample schematics and diagrams are indicated on typical detail Drawings for reference and understanding of minimum information required for submittal of

Shop Drawings schematics and diagrams, and submittal of O&M schematics and diagrams.

7. Include tagging system, labels, markers, hazard tape, nameplates, and signs.

B. Product Data: Include tagging system, labels, markers, and hazard tape.

C. Project Record Documents:

1. Document wire, cable, and conductor tags, and bundle tags installed in accordance with the Contract Documents.
2. Document installed wire, cable, and conductor tags and bundle tags when not specifically indicated.
3. Indicate on Record Drawings deviations from accepted Shop Drawing conductor identification.

1.5 QUALITY ASSURANCE

A. Pre-installation Meeting:

1. Conduct in accordance with Section 16000.
2. Purpose: To clearly define requirements specified for circuit/cable/conductor identification, hold a meeting including representatives of CONTRACTOR, DISTRICT, and ENGINEER prior to significant cable or conductor purchase and installation/termination.

PART 2 PRODUCTS

2.1 LABELS

A. Manufacturers: One of the following or equal:

1. Brady.
2. Seton.

B. Type: Sleeve type.

2.2 CONDUCTOR AND CABLE MARKERS

A. Manufacturers: One of the following or equal:

1. Brady.
2. Seton.

B. Type: Slip-on PVC sleeve or strap-on type.

C. Printed using Brady marker "XC PLUS," or equal.

D. Markers used in tunnels or other wet locations shall be on heat-shrinkable marking sleeves.

- E. Use self-laminating vinyl on white background for markers within electrical equipment such as panels, termination cabinets, motor control centers.
- F. Use engraved stainless steel tags with circuit designation fastened to direct buried cables in underground pull boxes as detailed on the drawings.

2.3 RACEWAYS IDENTIFICATION (TAGS)

- A. Conduit numbers shall be pressure stamped into a non corrosive 2 inch long, 1/2 inch wide stainless steel tape, Dymo marking system or equal. A tag with number shall be fixed with No. 18 AWG or larger type 304 stainless steel wire, to each conduit segment and at the end of each conduit and within 3 feet of each pull box, panelboard, MCC and switchboard.

2.4 NAMEPLATES, LABELS AND SIGNS

- A. Nameplates:
 - 1. Type: Black lamicoid with white letters.
 - 2. Fastener: Round head stainless steel screws.
- B. Automatic Equipment and High Voltage Warning Signs:
 - 1. Type: Suitable for exterior use and meeting OSHA regulations.
- C. Power Pole Labels: Vinyl plastic with details as shown on the drawings.
 - 1. Manufacturers: One of the following or equal:
 - a. Brady.
 - b. Seton.
- D. Underground Hazard Tape: 6 inches wide. Detectable, aluminum with warning wording.
 - 1. Manufacturers: One of the following or equal:
 - a. Panduit.
 - b. Thomas and Betts.

PART 3 EXECUTION

3.1 CIRCUIT IDENTIFICATION

- A. Identify 3-phase system conductors and cables as Phases A, B, and C and identify 1-phase system conductors and cables at electrical equipment including, but not limited to, switchgear, switchboards, panelboards, motor control centers, and motors.
 - 1. Match DISTRICT's existing electrical system identification scheme or meet requirements of the authority responsible for the project.
 - 2. 3-phase 480 Volts AC System Conductors: Phase A, brown; Phase B, orange; Phase C, yellow.

3. Single-Phase Conductors for 120/240 VAC Circuits: Phase A, black; Phase B, red; Phase C, blue.
 4. Neutral Conductor: White for 120 VAC and gray for 277 VAC.
 5. Insulated Equipment Grounding Conductor: Green.
 6. General Purpose AC Control Conductors: Violet.
 7. General Purpose DC Control Conductors: Violet with white stripes.
 8. Where used, identify 15 kilovolt class cables with 3 stripes of color tape specified in item 3 above.
 9. Where used, identify 5 kilovolt cable with 2 stripes of color tape specified in item 3 above.
- B. Use color coding and phasing consistent throughout the site. Bus bars at panelboards and motor control centers to be connected Phase A-B-C, top to bottom, or left to right facing connecting lugs.
 - C. Conductors Number 2 American Wire Gauge (AWG) and smaller to be factory color coded with a separate color for each phase and neutral, which shall be used consistently throughout the system. Larger cables to be coded by the use of colored tape.
 - D. In addition to color coding, for all 1-phase and 3-phase systems, identify each cable (single or multi-conductor) and conductor at each end, in each manhole, pullbox, cable tray, or other component of the raceway system. This identification is applicable to all power, control, alarm, signal, instrumentation cables, and conductors.
 - E. Identify each cable (single or multi-conductor) and groups or bundles of individual single conductors in each manhole, pullbox, cable tray, or other component of the raceway system with circuit identification markers. Implement a "from-to" cable/conductor bundle tagging system as part of this identification effort.
 - F. Identify each individual conductor at each termination and in manhole and underground or above ground pull boxes. This includes such locations as switchgear, switchboards, motor control centers, variable frequency drives, control panels, junction/terminal boxes, all field devices, and all other locations where conductors are terminated. Identify the termination of these conductors in accordance with the accepted Shop Drawings. Tag conductors with sleeve type labels.
 - G. Where more than 1 nominal voltage system exists, identify each ungrounded system conductor by phase and system. Permanently post means of identification at each branch-circuit panelboard, switchboard, switchgear, motor control center, or other type of power distribution equipment.
 - H. Include the following minimum information for wire and cable identification.
 1. Circuit number or load identification tag number as per section 16995.
 2. Origin (from source).
 3. Destination (to load).

3.2 NAMEPLATES

- A. Furnish and install nameplates for all electrical equipment indicated on the Drawings. Each disconnect, control system, control panel, breaker, switch, panelboard, MCC, switchboard, control panel, etc., shall have nameplate indicating equipment name and circuit designation.
- B. Each disconnect means for service, feeder, branch, or equipment conductors and pushbutton stations shall have nameplates indicating its purpose or identifying the load.
- C. Each lighting switch and convenience outlet shall have a nameplate indicating its 120VAC power circuit number from lighting panelboard. Nameplate shall be affixed to the faceplate of the device with heavy duty adhesive cement.

3.3 AUTOMATIC EQUIPMENT WARNING

- A. Mount permanent warning signs at mechanical equipment which may be started automatically or from remote locations. Fasten warning signs with round head stainless steel screws or bolts, located and mounted in a manner acceptable to ENGINEER.
- B. Mount permanent and conspicuous warning signs on (front and back) equipment, doorways to equipment rooms, pull boxes, manholes, where the voltage exceeds 600 volts.
- C. Place a warning ribbon or other effective means suitable for conditions above ductbank underground installations.
- D. Place warning signs on utilization equipment that has more than one source of power. Provide panel and circuit number of conductor tag of the power source disconnect.
- E. Place warning signs on utilization equipment that has 120 VAC control voltage source used for interlocking. Provide panel, circuit number, and conductor tag of control voltage source disconnect.

3.4 CONDUIT TAGS

- A. Install conduit tags (engraved stainless steel round tags) at each conduit termination to control panel, MCC, enclosure, disconnect, pull box, junction box etc.. Conduit tag names shall be as per single-line and control one-line diagrams shown on the drawings.

END OF SECTION

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SECTION 16222 MOTORS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: Single phase motors, direct current motors, and 3-phase motors up to and including 400 horsepower.
- B. See Div 11 for submersible motors.

1.2 REFERENCES

- A. American Bearing Manufacturers Association (ABMA):
 - 1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
 - 2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
- B. Institute of Electrical and Electronic Engineers (IEEE).
- C. National Electrical Manufacturers' Association (NEMA):
 - 1. MG-1 - Motors and Generators.

1.3 DEFINITIONS

- A. Solid-State Motor Controller: Includes variable frequency drives and solid-state reduced voltage starters.
- B. Nominal Efficiency: The average full load efficiency value of a large population of the manufacturer's motors of the same design.
- C. Minimum Efficiency: The minimum full load efficiency value of any individual motor associated with the nominal motor efficiency.

1.4 SUBMITTALS

- A. Product Data:
 - 1. Descriptive bulletins.
 - 2. Outline Drawings with dimensions.
 - 3. Cut-away and exploded view Drawings.
 - 4. Parts list with material designations.
 - 5. Nameplate data.
 - 6. Motor weight, frame size, and conduit box location.
 - 7. Description of insulation system.
- B. Design and Performance Data:
 - 1. Bearing design and bearing life calculations.
 - 2. Performance Data Required by Schedule A, Nameplate Data, and Following Information:

- a. Service factor.
 - b. Efficiency at 1/2 and 3/4 load.
 - c. Power factor at 1/2 and 3/4 load.
 - d. When required for power factor improvement, capacitor size in KVAR with calculation data for motors sized 50 horsepower and above.
- 3. Special features including condensation heaters and winding temperature detectors.
- 4. Performance data for motors with synchronous speed of 900 revolutions per minute and below.
- 5. Factory test reports with test reference standard identified.

1.5 QUALITY ASSURANCE

- A. Certification:
 - 1. When motors are driven by variable speed drive systems, submit certification that selected motor:
 - a. Is capable of satisfactory performance under the intended load.
 - b. Is suitable for operation with the proposed variable speed drive unit.
- B. Rating:
 - 1. All motors provided for this project shall be suitable for an elevation of 1,250 feet without derating.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Motors: One of the following or equal:
 - 1. U. S. Motors.
 - 2. General Electric.
 - 3. Reliance.

2.2 ELECTRICAL MOTORS

- A. General:
 - 1. Manufactured with cast iron frames in accordance with NEMA MG 1, and in accordance with specified requirements.
 - 2. Alternating Current Motors: Squirrel cage induction type suitable for 60 hertz power.
 - 3. Where not otherwise specified or indicated on the Drawings:
 - a. Motors 1 Horsepower and Larger: 3-phase, 460 volt AC
 - b. Motors less than 1 Horsepower: Single phase, 120 volt AC
 - 4. 2-Speed Motors: Dual winding design.
 - 5. Temperature Rating and Altitude Requirements: Where not otherwise specified or indicated on the Drawings, provide motors that are rated suitable for continuous operation in 40 degree Celsius ambient temperature at project site altitude.
 - a. Temperature Rise Under Full Load: Not to exceed that for Class B insulation (80 degrees Celsius).

6. Motor Data: Specific motor data including horsepower, speed, and enclosure type are indicated on the Drawings and specified under equipment for which motor is required.
 7. Torque and Power of Motors:
 - a. Provide motors that develop sufficient torque for required service throughout acceleration range at voltage 10 percent less than motor nameplate rating.
 - b. Provide motors that develop sufficient torque when started using reduced voltage starters.
 8. Motor Leads and Insulating Material: Insulated leads with non-wicking, non-hydroscopic material. Class F insulation.
 9. Grounding Lugs: Provide inside conduit boxes for motor frame grounding.
 10. Hardware: Type 316 stainless steel.
- B. Provide motors that are special premium efficiency type, except motors that are to be used on hoisting equipment, heat pumps, unit heaters, sump pumps, and lubricating oil transfer pumps.
1. Provide premium efficiency type motors having nominal full load efficiencies and power factors as specified in Schedule A appended to this Section.
 2. Actual full load efficiency of individual motors within the nominal efficiency band shall not be less than the minimum efficiency value specified in Schedule A.
- C. Condensation Heaters:
1. Use: Required in motors in outdoor applications.
 2. Type: Cartridge or flexible wrap-around type installed within motor enclosure adjacent to core iron.
 3. Rating, Phase and Wattage: Rated for 120 volt, single phase with wattage as required.
 4. Bring power leads for heaters into conduit box.
- D. Winding Temperature Detectors:
1. When specified for individual equipment and on alternating current motors connected to a solid-state motor controller, provide factory installed winding temperature detector with leads terminating in conduit box.
 2. Provide detectors that protect motor against damage from overheating caused by single phasing, overload, high ambient temperature, abnormal voltage, locked rotor, frequent starts, or ventilation failure.
 - a. For Motors Less than 200 Horsepower: Provide detector that has normally closed contacts.
 - b. For Motors 200 Horsepower and Larger: Provide with resistance temperature detectors, 2 per each phase.
 3. Auxiliary Relays and Controls: Provide relays and controls and mount them in controller enclosure which is suitable for the environment.
- E. Internal Cooling Motors: Design motors having speeds of 900 revolutions per minute and less, and motors that are connected to solid-state motor controllers with special attention to internal cooling.

2.3 SINGLE PHASE MOTORS

- A. Capacitor start type rated for operation at 115 volts, 60 hertz, unless otherwise specified or indicated on the Drawings.

- B. Totally enclosed, fan cooled motors manufactured in accordance with NEMA MG 1-10.35.
- C. Ball Bearings: Sealed.
- D. 1/2 Horsepower or Less Fan Motors:
 - 1. Split-phase or shaded pole type when standard for the equipment.
 - 2. Open type when suitably protected from moisture, dripping water, and lint accumulation.
- E. Wound rotor or commutator type single-phase motors only when their specific characteristics are necessary for application and their use is acceptable to the ENGINEER.

2.4 3-PHASE MOTORS

- A. Suitable for 460 volt 3-phase power unless otherwise specified or indicated on the Drawings.
- B. NEMA Design B except where driven load characteristics require other than normal starting torque.
 - 1. Starting kilovolt ampere per horsepower (locked rotor) are not to exceed values specified in NEMA MG-1-10.37.
- C. Motor Bearings: Antifriction, regreasable, and filled initially with grease suitable for ambient temperatures to 40 degrees Celsius.
 - 1. Suitable for intended application and have ABMA B-10 rating life of 60,000 hours or more.
 - 2. Fit bearings with easily accessible grease supply, flush, drain, and relief fittings using extension tubes where necessary.
 - 3. Provide two pole motors with sleeve type bearings.
- D. Insulation Systems:
 - 1. Comply with NEMA 1-1.65.
 - 2. Class F system with Class B temperature rise.
 - 3. Resistant to attack by moisture, acids, alkalies, and mechanical or thermal shock.
- E. Conduit Boxes: Cast iron or stamped steel, split from top to bottom and capable of being rotated to 4 positions.
 - 1. Provide gaskets between following:
 - a. Frames and conduit boxes.
 - b. Conduit boxes and box covers.
- F. Motor Enclosures: When enclosure type is not specified in individual equipment specifications, provide a Totally Enclosed Fan Cooled (TEFC) enclosure for non-hazardous (unclassified) areas and explosion-proof enclosure for hazardous (classified) areas:
 - 1. Totally Enclosed Fan Cooled: Cast iron conduit box; 1.15 service factor at 40 degrees Celsius ambient; tapped drain holes with Type 316 stainless steel plugs for frames 286T and smaller, and automatic breather and drain devices for

- frames 324T and larger; upgraded insulation by minimum of 3 dips and bakes and sealer coat of epoxy or silicone.
2. Explosion-Proof: 1.15 service factor at 40 degrees Celsius; tapped drain holes with corrosion resistant plugs for frames 286T and smaller and automatic breather and drain devices for frames 324T and larger; UL label for Class I, Division 1, Group D hazardous area.
 3. For special application such as corrosive environment, use a Severe Duty motor. Corrosion resistant type conforming to motors designated by manufacturer as "Chemical Duty," "Mill and Chemical," "Custom Severe Duty," or similar applicable manufacturer's quality designation with 1.15 service factor at 40 degrees Celsius; tapped drain holes with Type 316 stainless steel plugs for frames 286T and smaller and automatic breather and drain devices for frames 324T and larger; epoxy finish; and upgraded insulation using encapsulated or dip and bake windings.
 4. Submersible: Watertight casing with insulated windings which are moisture resistant.
 - a. Pump Motors Specified to be Submersible: Provide motors having cooling characteristics suitable for continuous operation in totally, partially, or non-submerged condition without overheating or other damage.
 - b. Electrical Cables: Provide cables of adequate length to allow unit to be wired without splices.
 5. Open Drip Proof where specified elsewhere: Stamped steel conduit boxes; 1.15 service factor at 40 degrees Celsius.

2.5 MOTOR SIZES

- A. Motor sizes specified in the Specifications and indicated on the Drawings are minimum sizes.
- B. Provide motors, electrical circuits, and equipment of ample horsepower capacity to operate equipment without exceeding rated nameplate horsepower, full-load current at rated nameplate voltage, or overheating at maximum load capacity.

2.6 SOURCE QUALITY CONTROL

- A. Factory Testing of 3-Phase Motors:
 1. When specified in individual equipment Specifications, factory test motors. Include testing of:
 - a. No load current.
 - b. Locked rotor current.
 - c. Winding resistance.
 - d. High potential.
 2. Perform in accordance with applicable NEMA Standards.
 3. Furnish copies of test reports.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install motors in accordance with manufacturer's instructions.

3.2 SCHEDULES

- A. Schedule A: Full load motor efficiency and power factor rating requirements for premium efficiency, 460 volt, 3-phase horizontal motors.

<u>SCHEDULE A</u>							
FULL LOAD MOTOR EFFICIENCY AND POWER FACTOR RATING REQUIREMENTS FOR PREMIUM EFFICIENCY, 460 VOLT, 3 PHASE HORIZONTAL AND VERTICAL MOTORS							
		Protected (Open Drip Proof)⁽¹⁾			Totally Enclosed Fan Cooled⁽¹⁾		
Nominal Horsepower (Horsepower)	Syn. (revolutions per minute)	Minimum Efficiency (Percent)	Nominal Efficiency (Percent)	Power Factor (Percent)	Minimum Efficiency (Percent)	Nominal Efficiency (Percent)	Power Factor (Percent)
1	1,800	81.5	84.0	70.9	81.5	84.0	77.7
	1,200	78.5	81.5	57.0	78.5	81.5	57.0
2	3,600	81.5	84.0	87.7	84.0	86.5	87.7
	1,800	81.5	84.0	76.7	81.5	84.0	78.8
	1,200	84.0	86.5	68.1	85.5	87.5	68.1
3	3,600	80.0	82.5	90.4	84.0	86.5	82.8
	1,800	86.5	88.5	78.9	86.5	88.5	79.2
	1,200	87.5	89.5	71.0	87.5	89.5	71.0
5	3,600	86.5	81.5	84.5	86.5	88.5	87.0
	1,800	87.5	88.5	80.4	86.5	88.5	81.0
	1,200	88.5	89.5	73.0	87.5	89.5	74.4
	900	87.5	87.5	70.0	87.5	89.5	70.5
7-1/2	3,600	86.5	88.5	86.7	87.5	89.5	86.3
	1,800	87.5	89.5	83.3	88.5	90.2	84.4
	1,200	88.5	90.2	78.2	88.5	90.2	78.3
	900	87.5	89.5	72.0	87.5	89.5	72.0

<u>SCHEDULE A</u> FULL LOAD MOTOR EFFICIENCY AND POWER FACTOR RATING REQUIREMENTS FOR PREMIUM EFFICIENCY, 460 VOLT, 3 PHASE HORIZONTAL AND VERTICAL MOTORS							
		Protected (Open Drip Proof) ⁽¹⁾			Totally Enclosed Fan Cooled ⁽¹⁾		
Nominal Horsepower (Horsepower)	Syn. (revolutions per minute)	Minimum Efficiency (Percent)	Nominal Efficiency (Percent)	Power Factor (Percent)	Minimum Efficiency (Percent)	Nominal Efficiency (Percent)	Power Factor (Percent)
10	3,600	88.5	90.2	85.5	89.5	91.0	87.5
	1,800	88.5	90.2	82.8	88.5	90.2	86.0
	1,200	89.5	91.0	80.5	89.5	91.0	81.0
	900	89.5	91.0	75.8	88.5	90.2	76.0
15	3,600	88.5	90.2	86.7	89.5	91.0	87.4
	1,800	90.2	91.7	81.9	91.0	92.4	82.7
	1,200	89.5	91.0	81.7	90.2	91.7	78.9
	900	89.5	91.0	76.8	88.5	90.2	77.0
20	3,600	90.2	91.7	87.1	90.2	91.7	88.7
	1,800	91.0	92.4	83.1	91.0	92.4	84.2
	1,200	90.2	91.7	83.7	90.2	91.7	79.0
	900	90.2	91.7	77.2	89.5	91.0	77.2
25	3,600	90.2	91.7	88.1	91.0	92.4	85.5
	1,800	91.7	93.0	82.7	92.4	93.6	84.3
	1,200	91.0	92.4	79.2	91.0	92.4	83.5
	900	90.2	91.7	76.3	90.2	91.7	76.4
30	3,600	91.7	93.0	88.3	91.0	92.4	73.9
	1,800	91.7	93.0	83.3	92.4	93.6	83.1
	1,200	91.7	93.0	82.1	91.7	93.0	83.5
	900	91.7	93.0	76.0	91.0	92.4	76.5

SCHEDULE A

FULL LOAD MOTOR EFFICIENCY AND POWER FACTOR RATING REQUIREMENTS FOR PREMIUM EFFICIENCY, 460 VOLT, 3 PHASE HORIZONTAL AND VERTICAL MOTORS

		Protected (Open Drip Proof)⁽¹⁾			Totally Enclosed Fan Cooled⁽¹⁾		
Nominal Horsepower (Horsepower)	Syn. (revolutions per minute)	Minimum Efficiency (Percent)	Nominal Efficiency (Percent)	Power Factor (Percent)	Minimum Efficiency (Percent)	Nominal Efficiency (Percent)	Power Factor (Percent)
40	3,600	92.4	93.6	89.2	92.4	93.6	87.5
	1,800	93.0	94.1	80.8	93.0	94.1	82.3
	1,200	92.4	93.6	82.2	92.4	93.6	80.5
	900	91.7	93.0	75.0	91.7	93.0	75.5
50	3,600	91.7	93.0	86.3	91.7	93.0	87.7
	1,800	93.0	94.1	83.3	93.0	94.1	84.2
	1,200	92.4	93.6	83.0	92.4	93.6	80.6
	900	92.4	93.6	79.2	91.7	93.0	79.5
60	3,600	92.4	93.6	88.8	92.4	93.6	88.9
	1,800	94.1	95.0	84.5	94.1	95.0	84.2
	1,200	93.6	94.5	84.4	93.0	94.1	85.4
	900	92.4	93.6	78.8	91.7	93.0	79.3
400	1800	95.4	96.2	90.1	93.4	94	88.4
	1200	96.3	96.7	86.5	95.2	95.5	80.3
	900	96.3	96.5	77.5	95.2	95.4	72.7

NOTES:

- (1) Motor data for continuous duty, NEMA Design B, 1.15 service factor, 40 degrees Celsius ambient, Class F insulation, 3 phase, 460 volt, at listed speed rating.
- (2) Correct to 95 percent power factor and submit capacitor size in KVAR as specified in Article titled "Submittals."
- (3) Totally enclosed fan cooled efficiencies apply to both horizontal and vertical motors.

END OF SECTION

SECTION 16422 MOTOR CONTROL

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: Manual starters, magnetic contactors, overload relays, combination starters and related motor controllers.
- B. Related Sections:
 - 1. Section 16000 – Requirements for Electrical Work
 - 2. Section 16920 – 600V Motor Control Center

1.2 REFERENCES

- A. National Electrical Code (NEC):
 - 1. Article 430 - Motors, Motor Circuits and Controllers.
- B. National Electrical Manufacturers Association (NEMA).
- C. Underwriter Laboratories (UL)

1.3 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 16000.
- B. Manufacturer's installation instructions.

1.4 WARRANTY

- A. Submit manufacturer's standard warranty.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Manual Motor Starters: One of the following or equal:
 - 1. Square D Company.
 - 2. Allen-Bradley.
 - 3. General Electric/ABB.
- B. Full Voltage Magnetic Starters: One of the following or equal:
 - 1. GE/ABB.
 - 2. Allen-Bradley.
 - 3. Square D Company.
- C. Reduced Voltage Solid-State Starters: One of the following or equal:
 - 1. GE/ABB.

2. Square D Company.
3. Allen-Bradley.

2.2 STARTERS

- A. Suitable for the horsepower ratings specified, and in accordance with NEC Article 430.
- B. Verify motor ratings and coordinate starter and overload trip ratings with actual horsepower and nameplate current ratings of motors installed.
- C. Magnetic Contactors: Factory adjusted and chatter free.
- D. Overload Relays: Install bimetallic type overload relays in each line conductor as indicated on the Drawings. Provide contacts for remote monitoring of overload status as indicated on the Drawings.
- E. Mount extended overload reset buttons to be accessible for operation without opening door of enclosure. Plastic overload relay reset buttons with plastic operator shafts are unacceptable.
- F. Provide starters Size 2 and larger with arc quenchers on load breaking contacts.
- G. Minimum Size Starter: NEMA Size 1, and not smaller than size indicated on the Drawings.
- H. Provide starters of sufficient size to accommodate motors furnished, including larger starters required for larger motors supplied by CONTRACTOR.
- I. Combination Starters: Furnish complete with a 120 volt control transformer and accessories unless otherwise noted.
- J. Control Fuses: Size and furnish as required and where indicated in the schematics.

2.3 MANUAL MOTOR STARTERS

- A. Across-the-line manual motor starters for motors up to 1 horsepower, 600 volts shall have the electrical characteristics indicated on the Drawings.
- B. Provide single-pole or 3 pole as indicated on the Drawings with overload devices.
- C. Provide handles that clearly indicate the ON, OFF with lockout, and TRIPPED positions, pilot light, and positive, quick-make, quick-break mechanisms.
- D. Provide enclosures as indicated on the Drawings. Where not indicated, provide NEMA 12 enclosures for indoor location and NEMA 3R or 4X stainless steel enclosures for outdoor locations and corrosive, chemical areas. Provide enclosures compatible with type of conduit system being used for each specific application.

2.4 FULL VOLTAGE MAGNETIC STARTERS

- A. Across-the-line full voltage magnetic starters for up to 600 volts shall have electrical characteristics indicated on the Drawings.

- B. Provide positive, quick-make, quick-break mechanisms; padlockable enclosure doors; 3 overload relays with plus or minus 15 percent adjustment from nominal heater rating on the overload relay; cover mounted reset button, and at least 3 reversible contacts in addition to hold-in contact.
- C. Provide magnetic starter enclosures as indicated on the Drawings. Where not indicated, provide NEMA 12 enclosures for indoor locations and NEMA 3R or 4X stainless steel enclosures for outdoor locations and corrosive, chemical areas. Provide enclosures compatible with type of conduit being used for each specific application.
- D. Provide magnetic starters in accordance with latest NEMA Standards.
- E. Provide pilot devices such as push buttons, pilot lights (push-to-test type), running time meter, motor protector modules as shown on the drawings.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install motor starters in accordance with section 16000.

3.2 APPLICATION

- A. Supply circuit breaker trip elements and starter overload trip elements to meet above normal ambient temperatures where such conditions are anticipated (subject to ENGINEER's acceptance).

3.3 DEMONSTRATION

- A. Demonstrate successful operation of equipment.

3.4 PROTECTION

- A. Protect products until acceptance by DISTRICT.

END OF SECTION

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**SECTION 16920
600 VOLT MOTOR CONTROL CENTERS**

PART 1 GENERAL

1.1 DESCRIPTION

- A. Scope: This section specifies existing freestanding, factory assembled 600 volt motor control center section (MCC) to be modified as shown in the drawings.
- B. Equipment List: MCCs and accessories specified herein shall be manufactured by Eaton and Allen-Bradley to match existing installation.

1.2 RELATED SECTIONS

- A. Section 16000 – Requirements for Electrical Work.

1.3 REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ANSI/NEMA ICS 1-88	General Standards for Industrial Controls and Systems
ANSI/NEMA ICS 2-88	Industrial Control Devices, Controllers and Assemblies
JIC EMP 1-67	Electrical Standards for Mass Production Equipment
UL 845-88	Motor Control Centers

1.4 SUBMITTALS

- A. The following specific submittal requirements for the MCC's shall be followed:
 - 1. Contractor shall use Eaton components for the required modifications to the existing MCC-P1 in this project. For existing Allen-Bradley MCC-HW, use Allen-Bradley components accordingly.

- B. The following information contain in three-ring binder shall be provided and submitted in accordance with Section 16000:
1. Elementary connection, single-line diagram, individual equipment control schematic diagrams, and interconnection diagrams as required in accordance with JIC EMP 1 and/or NEMA ICS standards. Each and every terminal shall be identified with terminal number. Remote mounted pilot devices shall also be identified on wiring diagram.
 2. List of starters and feeder tap compartments indicating the size and type of circuit protection. Nameplate schedule for each equipment compartment door shall also be submitted.
 3. Interrupting withstand and continuous current rating of:
 - a. Bus bars
 - b. Feeder tap units
 - c. Starter units
 - d. Main incoming units

PART 2 PRODUCTS

2.1 ACCEPTABLE PRODUCTS

- A. Motor control centers shall comply with ANSI/NEMA ICS 2-322, AC General-Purpose Motor Control Centers, Allen-Bradley, Eaton (Cutler-Hammer)
- B. Circuit Breakers (Thermal Magnetic): Thermal-magnetic circuit breakers shall be molded case equipped with toggle type handle, quick-make, quick-break over center switching mechanism that is trip-free so that breaker cannot be held closed against short circuits and abnormal currents. The tripped position shall be clearly indicated by breaker handle maintaining a position between "ON" and "OFF." All poles shall open, close, and trip simultaneously. Minimum short circuit capacity shall be 65,000 amps symmetrical at 480V AC. Molded case breaker of 200 amp or larger shall be provided with solid-state multi function trip units with long time, long time delay, short time, short time delay and ground fault protection. Main breaker for MCC shall be provided with a shunt trip coil and with two auxiliary switches rated for 5A minimum. The shunt trip and its auxiliary contacts are for future use.
- C. Terminal Blocks: Terminal blocks shall be screw type rated 600 volts; 20 amperes for control wiring and 30 amperes power wiring (starters size 3 and larger shall terminate the power leads directly to the contactor). The number of terminal blocks shall be specified on the drawings. Terminal blocks shall be provided with integral marking strips and shall be permanently marked with the conductor number as specified on the drawings. Internal wiring shall be connected on one side of the terminal block; outgoing conductors shall be connected to the other side.
- D. Electrical Control Devices, Control Relays, Control and Power (Dry type) transformers shall be as per section 16000.

2.2 MISCELLANEOUS

A. General:

1. Control devices such as pushbuttons, selector switches, indicating lights (push-to-test type) and overload reset pushbuttons shall be mounted on the unit compartment door.
1. The control devices shall comply with the requirements of applicable DIV 16 section.

B. Nameplates: Nameplates shall be provided in accordance with the requirements of paragraph 16075-2.4 Nameplates shall be provided for all cubicles and compartments. A Master nameplate with large lettering (one-inch high) shall be provided identifying name of the motor control center. In addition, provide a sign to indicate that "This electrical gear is supported by an emergency generator located on the outside of the MCC building" in accordance with NEC Article 700.

PART 3 EXECUTION

3.1 GENERAL

- A. The motor control center sections shall be erected in accordance with the recommendations of the manufacturer and with the details specified herein.
- B. The overload relay heater elements class 20 shall be provided by the Contractor and sized based on the actual full load amperes of the motor connected to the starter. Provide a summary of all overload heaters including the motor nameplate data and corresponding overload heater catalog number and rating as part of as-built drawings for review and approval.
- C. The motor circuit protectors shall be adjusted by the Contractor to the lowest setting not causing false tripping.
- D. Install anchor bolts to hold down MCC as per typical detail shown on the drawing to resist seismic activities. Install anchor bolts to hold down auxiliary enclosure as per the manufacturer's requirements to meet seismic requirements per California Building Code. Caulk around the base of the auxiliary enclosure after installation.
- E. Provide color coded tapes and circuit identification to all power cables and terminals. Refer to Section 16000 for color assignment.
- F. For modified sections of the MCC, new compartment doors shall be required for new devices.

3.2 FIELD TESTS

- A. Motor control centers modified components shall be tested in accordance with Section 16000 and Section 16940. Testing shall include individual starters and breakers. Submit

final as-built prior to performing final acceptance test. Field test records to be submitted shall include data such as motor nameplate rating, overload catalog number and rating and actual full load current drawn by the installed equipment. This data shall be included in the final O&M submittal

END OF SECTION

SECTION 16950 ELECTRICAL TESTING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: Acceptance testing of electrical system, wiring, equipment, and grounding.
- B. Related Sections:
 - 1. 16000 – Requirements for Electrical Work.

1.2 REFERENCES

- A. National Electrical Testing Association (NETA):
 - 1. ATS-1995: Acceptance Testing Specifications for Electric Power Distribution Equipment and Systems.
- B. ANSI: Test Procedures for Electrical Equipment.
- C. ASTM: American Society for Testing and Materials.
- D. ANSI/IEEE: Recommended Practices for Testing: Machinery, Ground Impedance, Cables and Terminations.

1.3 SUBMITTALS

- A. Pre-Test Submittals:
 - 1. Testing service qualifications.
 - 2. Test personnel qualifications (resumes).
 - 3. Equipment testing schedule.
 - 4. Test data forms, custom edited for difference types of electrical equipment. Test forms shall be specific for the tested equipment, the Owner (District), and the location. Non-conformance forms shall be rejected.
- B. Post-Test Submittals: Summary Test Report consists of the following:
 - 1. Summary of testing for the project.
 - 2. Description of the equipment tested.
 - 3. Description of the test and test procedures.
 - 4. Test results for each apparatus and motorized equipment.
 - 5. Conclusions and recommendations.
 - 6. Completed test forms, including tester's and witness's signatures.
 - 7. List of test equipment and calibration documents.
 - 8. Date and time.
 - 9. A copy of this specification section with each paragraph check marked indicating compliance or marked with explicit deviations.

- C. Submit Equipment Testing Schedule no later than 7 days prior to scheduled date of testing.
- D. Project Record Documents: Submit as specified in Section 16000. Note or indicate wiring deviations from Contract Documents on Project Record Documents.

1.4 QUALITY ASSURANCE

- A. Testing Firm Qualifications:
 - 1. Obtain the services of an independent testing service firm that meets the Federal OSHA criteria for accreditation of testing laboratories, Title 29, Part 1910.7 and has a work history and qualifications acceptable to ENGINEER.
 - 2. Prequalified Testing Services and Manufacturing Firms:
 - a. General Electric Company.
 - b. Square D Company Technical Service Divisions.
 - c. Electrical Reliability Services/Emerson
 - d. Siemens/Westinghouse Technical Services.
 - 3. Testing service or testing personnel may be accepted or rejected based upon, but not limited to, the testing equipment intended to be used, the qualifications of the firm, and personnel.
- B. Test Equipment Traceability:
 - 1. Testing firm shall have a calibration program to maintain test instrumentation and equipment within rated accuracy, including stickers with calibration dates record.
 - 2. Equipment and instruments used to evaluate electrical performance shall be calibrated to a standard traceable to the National Institute of Standards and Technology.
 - 3. Test equipment operating instructions and procedures shall be with the test equipment.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.1 SAFETY AND PRECAUTIONS

- A. Testing firm shall perform tests following a safe practice in accordance with OSHA and accident prevention procedures by National Safety Council and applicable codes.
- B. Tests shall be performed with apparatus de-energized, except as necessary for equipment performance and functional test.

3.2 EXAMINATION

- A. Verify that electrical work is free from improper grounds, short circuits, and overloads.

- B. Verify correctness of wiring first by visual comparison of the conductor connections with connection diagrams.
- C. Make individual circuit continuity checks by using electrical circuit testers.
- D. Verify correctness of wiring by actual electrical operation of electrical and mechanical devices in both manual and automatic modes of operation.

3.3 IMPLEMENTATION OF POWER SYSTEMS STUDIES

- A. Prior to perform acceptance testing, the testing firm shall inspect and verify adequate short circuit rating of electrical equipment as determined by the short circuit study specified in Section 16938.
- B. The testing firm shall implement the adequate settings and calibration of protective relays, circuit breakers, fuses and other applicable protective devices as recommended in the protective devices coordination study in Section 16938.

3.4 ACCEPTANCE TESTING

- A. General Requirements:
 1. Perform testing and allow DISTRICT and ENGINEER to witness testing.
 2. Perform tests to assure that electrical equipment will operate within industry and manufacturer's published tolerances, and will perform safely. Record test result data, to be used as a baseline for future tests.
 3. Test motorized equipment to verify conformance with the Contract Documents and for acceptance.
 4. Equipment for which acceptable test data has not been submitted, or has been submitted but rejected, shall be deemed as not meeting Contract requirements.
- B. Equipment and Materials Inspection and Test Procedures. Complete test reports for each individual piece of equipment and systems:
 1. Switchboard Assemblies (Low Voltage):
 - a. Visual and Mechanical Inspection:
 - 1) Compare equipment nameplate and data with drawings and specifications.
 - 2) Inspect physical, electrical, and mechanical condition.
 - 3) Confirm correct application of manufacturer's recommended lubricants.
 - 4) Verify appropriate anchorage, required area clearances, physical damage, and correct alignment.
 - 5) Inspect all doors, panels, and sections for paint, dents, scratches, fit, and missing hardware.
 - 6) Verify that fuse and/or circuit breaker sizes and types correspond to drawings and coordination study as well as to the circuit breaker's address for microprocessor-communication packages.
 - 7) Verify that current and potential transformer ratios correspond to drawings.
 - 8) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.

- 9) Confirm correct operation and sequencing of electrical and mechanical interlock systems.
 - a) Attempt closure on locked-open devices. Attempt to open locked-closed devices.
 - b) Make key exchange with devices operated in off-normal positions.
- 10) Clean Switchboard.
- 11) Inspect insulators for evidence of physical damage or contaminated surfaces.
- 12) Verify correct barrier and shutter installation and operation.
- 13) Exercise all active components.
- 14) Inspect all mechanical indicating devices for correct operation.
- 15) Verify that filters are in place and/or vents are clear.
- 16) Test operation, alignment, and penetration of instrument transformer withdrawal disconnects, current-carrying and grounding.
- 17) Inspect control power transformers.
 - a) Inspect physical damage, cracked insulation, broken leads, and tightness of connections, defective wiring, and overall general condition.
 - b) Verify that primary and secondary fuse ratings or circuit breakers match drawings.
 - c) Verify correct functioning of draw out disconnecting and grounding contacts and interlocks.
- b. Electrical Tests:
 - 1) Perform tests on all instrument transformers.
 - 2) Perform ground-resistance tests.
 - 3) Perform resistance tests through ball bus joints with a low-resistance ohmmeter. Any joints that cannot be directly measured due to permanently installed insulation wrap shall be indirectly measured from closet accessible connection.
 - 4) Perform insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground.
 - 5) Perform an over potential or megger test on each bus section, each phase-to-ground with phases not under test grounded, in accordance with manufacturer's published data.
 - 6) Perform control wiring performance test.
 - 7) Perform current injection tests on the entire current circuit in each section of switchboard.
 - 8) Determine accuracy of all meters and calibrate.
 - 9) Perform phasing check on double-ended switchboard to insure correct bus phasing from each source.
 - 10) Perform the following tests on control power transformers.
 - a) Perform insulation-resistance tests. Perform measurements from winding-to-winding and each winding-to-ground.
 - b) Perform secondary wiring integrity test. Disconnect transformer at secondary terminals and connect secondary wiring to correct secondary voltage. Confirm correct potential at all devices.
 - c) Verify correct function of control transfer relays located in switchgear with multiple power sources.
 - 11) Potential Transformer Circuits:

- a) Perform secondary wiring integrity test. Disconnect transformer at secondary terminals and connect secondary wiring to correct secondary voltage. Confirm potential at all devices.
 - 12) Verify operation of switchgear/switchboard heaters.
- 2. Protective Relays: All relays installed on switchboard shall be tested regardless if the units are not indicated on the subsequent list.
 - a. Visual and Mechanical Inspection
 - 1) Compare equipment nameplate data with drawing and specifications.
 - 2) Inspect relays and cases for physical damage. Remove shipping restraint material.
 - 3) Tighten case connections. Inspect cover for correct gasket seal. Clean cover glass. Inspect shorting hardware, connection paddles, and/or knife switches. Remove any foreign material from the case. Verify target reset.
 - 4) Inspect relay for foreign material, particularly in disc slots of the damping and electromagnets. Verify disk clearance. Verify contact clearance and spring bias. Inspect spiral spring convolutions. Inspect disk and contacts for freedom of movement and correct travel. Verify tightness of mounting hardware and connections. Burnish contacts. Inspect bearings and/or pivots.
 - 5) Set relays in accordance with coordination study supplied by Waste Management.
 - b. Electrical Tests
 - 1) Perform insulation-resistance test on each circuit-to-frame. Determine from the manufacturer's instructions the allowable procedures for this test for the solid-state and microprocessor-based relays.
 - 2) Inspect targets and indicators
 - a) Determine pickup and dropout of electromechanical targets.
 - b) Verify operation of all light-emitting diode indicators.
 - c) Set contrast for liquid-crystal display readouts.
- 3. Instrument Transformers
 - a. Visual and Mechanical Inspection
 - 1) Compare equipment nameplate and data with drawings and specifications.
 - 2) Inspect physical and mechanical condition.
 - 3) Verify correct connection of transformers with system requirements.
 - 4) Verify that adequate clearances exist between primary and secondary circuit wiring.
 - 5) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
 - 6) Verify that all required grounding and shorting connections provide contact.
 - 7) Verify correct operation of transformer withdrawal mechanism and grounding operation.
 - 8) Verify correct primary and secondary fuse sizes for potential transformers.
 - b. Electrical Tests - Current Transformers

- 1) Perform insulation-resistance test of the current transformer and wiring-to-ground at 1000 volts dc. Do not perform this test on solid-state devices.
- 2) Perform a polarity test of each current transformer.
- 3) Perform a ratio-verification test using the voltage or current method in accordance with ANSI C57.13.1 (IEEE Guide to Field Testing of Relaying Current Transformers).
- 4) Measure current circuit burdens at transformer terminals and determine the total burden.
- c. Electrical Tests - Voltage Transformers
 - 1) Perform insulation-resistance test winding-to-winding and each winding-to-ground. Do not perform this test with solid-state devices connected.
 - 2) Perform a polarity test on each transformer to verify the polarity marks or H1-X1 relationship as applicable.
 - 3) Perform a turn's ratio test on all tap positions, if applicable.
4. Metering
 - a. Visual and Mechanical Inspection
 - 1) Compare equipment nameplate and data with drawings and specifications.
 - 2) Inspect physical and mechanical condition.
 - 3) Verify tightness of electrical connections.
 - 4) Inspect cover gasket, cover glass, conditions of spiral spring, disc clearance, contacts, and case-shorting contacts, as applicable.
 - 5) Verify mechanically for freedom of movement, correct travel and alignment, and tightness of mounting hardware.
 - b. Electrical Tests
 - 1) Check calibration of meters at all cardinal points.
 - 2) Verify all instruments multipliers.
 - 3) Electrically confirm that current transformer and voltage transformer secondary circuits are intact.
5. Transformers
 - a. Visual and Mechanical Inspection
 - 1) Compare equipment nameplate and data with drawings and specifications.
 - 2) Inspect physical and mechanical condition.
 - 3) Verify removal of any shipping bracing after final placement.
 - 4) Inspect impact recorder prior to unloading, if applicable.
 - 5) Verify that alarm, control, and trip settings on temperature indicators are as specified.
 - 6) Verify that cooling fans and pumps operate correctly and that fan and pump motors have correct overcurrent protection.
 - 7) Verify operation of all alarm, control, and trip circuits from temperature and level indicators, pressure relief device, and fault pressure relay.
 - 8) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
 - 9) Verify correct liquid level in all tanks and bushings.
 - 10) Verify that positive pressure is maintained on nitrogen-blanketed transformers.

- 11) Perform specific inspections and mechanical tests as recommended by manufacturer.
 - 12) Verify correct equipment grounding.
 - b. Electrical Tests
 - 1) Perform insulation-resistance tests, winding-to-winding and each winding-to-ground with test voltage. Test duration shall be for ten minutes with resistances tabulated at thirty seconds, one minute, and ten minutes. Calculate polarization index.
 - 2) Perform a turns-ratio test on all no-load tap-changer positions and all load tap-changer positions. Verify that tap setting is as specified. Verify that winding polarities are in accordance with nameplate.
 - 3) Measure resistance of each high-voltage winding in each no-load tap-changer positions. Measure resistance of each low-voltage winding in each load tap-changer position, if applicable.
 - 4) If core ground strap is accessible, measure core insulation resistance at 500 volts dc.
 - c. Test Values
 - 1) Bolt-torque levels shall be in accordance with data by manufacturer.
 - 2) Insulation-resistance test values.
 - 3) The polarization index should be compared to manufacturer's factory test results. If manufacturer's data is not available, acceptance test results will serve as baseline data.
 - 4) Turns-ratio test results shall not deviate more than one-half percent from either the adjacent coils or the calculated ratio.
 - 5) Consult manufacturer if winding-resistance measurements vary more than one percent from adjacent windings.
 - 6) Consult manufacturer if core insulation is less than one megohm at 500 volts dc.
6. Low-Voltage Power Circuit Breakers where shown on the drawings.
- a. Visual and Mechanical Inspection
 - 1) Compare equipment nameplate and data with drawings and specifications.
 - 2) Inspect physical and mechanical condition.
 - 3) Confirm correct application of manufacturer's recommended lubricants.
 - 4) Inspect anchorage, alignment, and grounding. Inspect arc chutes. Inspect moving and stationary contacts for condition, wear, and alignment.
 - 5) Verify that all maintenance devices are available for servicing and operating the breaker.
 - 6) Verify that primary and secondary contact wipe and other dimensions vital to satisfactory operation of the breaker are correct.
 - 7) Perform all mechanical operator and contact alignment tests on both the breaker and its operating mechanism.
 - 8) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method. Refer to manufacturer's instructions.
 - 9) Check cell fit and element alignment.
 - 10) Check racking mechanism.
 - b. Electrical Tests

- 1) Perform a contact-resistance test.
 - 2) Perform an insulation-resistance test at 1000 volts dc from pole-to-pole and from each pole-to-ground with breaker closed and across open contacts of each phase.
 - 3) Make adjustments for the final settings in accordance with the coordination study supplied by Waste Management.
 - 4) Determine minimum pickup current by primary current injection.
 - 5) Determine long-time delay by primary current injection.
 - 6) Determine short-time pickup and delay by primary current injection.
 - 7) Determine ground-fault pickup and delay by primary current injection.
 - 8) Determine instantaneous pickup value by primary current injection.
 - 9) Activate auxiliary protective devices, such as ground-fault or under voltage relays, to insure operation of shunt trip devices. Check the operation of electrically-operated breakers in their cubicles.
 - 10) Verify correct operation of any auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free and anti-pump function.
 - 11) Check charging mechanism.
- c. Test Values
- 1) Bolt-torque levels shall be in accordance with data specified by manufacturer.
 - 2) Compare microhm or millivolt drop values to adjacent poles and similar breakers. Investigate deviations of more than 25 percent.
 - 3) Insulation resistance shall not be less than 100 megohms. Investigate values less than 100 megohms.
 - 4) Trip characteristics of breakers shall fall within manufacturer's published time-current tolerance bands.

7. Motor Control Centers, Motor Controllers and Motor Starters: Low Voltage

- a. Visual and Mechanical Inspection
- 1) Compare equipment nameplate and data with drawings and specifications.
 - 2) Inspect physical and mechanical condition.
 - 3) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
- b. Electrical Tests
- 1) Insulation Tests
 - a) Measure insulation-resistance of each combination starter, phase-to-phase and phase-to-ground, with the starter contacts closed and the protective device open. Test voltage shall be in accordance with manufacturer's instructions for devices with solid-state components.
 - b) Test the motor overload relay elements by injecting primary current through the overload circuit and monitoring trip time of the overload element.

Note: Test times for thermal trip units will, in general, be longer than manufacturer's curve if single-pole testing is performed. Optionally test with all poles in series for time test and each pole separately for comparison. (Refer to NEMA ICS 2-1993, Part 4.)

- c. Test Values
 - 1) Bolt-torque levels shall be in accordance with data specified by manufacturer.
 - 2) Insulation-resistance values.
 - 3) Overload trip times shall be in accordance with manufacturer's published data.
 - d. Motor Control Center Bus
 - 1) See section switchgear assemblies for inspection and tests of MCC bus.
8. Circuit Breakers: Low-Voltage Molded Case - 100 Amp or Larger Only
- a. Visual and Mechanical Inspection
 - 1) Compare equipment nameplate and data with drawings and specifications.
 - 2) Inspect circuit breaker for correct mounting.
 - 3) Operate circuit breaker to insure smooth operation.
 - 4) Inspect case for cracks or other defects.
 - 5) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
 - b. Electrical Tests
 - 1) Perform a contact-resistance test.
 - 2) Perform an insulation-resistance test at 1000 volts dc from pole-to-pole and from each pole-to-ground with breaker closed and across open contacts of each phase.
 - 3) Perform adjustments for the final settings in accordance with the coordination study.
 - 4) Perform long-time delay time-current characteristics tests by passing 300 percent through each pole separately unless series testing is required to defeat ground fault functions.
 - 5) Determine short-time pickup and delay by primary current injection.
 - 6) Determine ground-fault pickup and time delay by primary current injection.
 - 7) Determine instantaneous pickup current by primary injection using run-up or pulse method.
 - 8) Verify correct operation of any auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, and anti-pump function.
 - c. Test Values
 - 1) Bolt-torque levels shall be in accordance with data specified by manufacturer.
 - 2) Compare microhm or millivolt drop values to adjacent poles and similar breakers. Investigate deviations of more than 25 percent. Investigate any value exceeding manufacturer's recommendations.
 - 3) Insulation resistance shall not be less than 100 megohms.
 - 4) Trip characteristics of breakers shall fall within manufacturer's published time-current tolerance bands, including adjustment factors.
9. Rotating Machinery: AC Motors
- a. Visual and Mechanical Inspection

- 1) Compare equipment nameplate and data with drawings and specifications.
 - 2) Inspect physical and mechanical condition.
 - 3) Inspect for correct anchorage, mounting, grounding, connection, and lubrication.
 - 4) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
 - 5) When applicable, perform special tests such as air gap spacing and pedestal alignment.
 - 6) Verify the absence of unusual mechanical or electrical noise or signs of overheating during initial test run.
 - b. Electrical Tests: Induction Motors
 - 1) Perform insulation-resistance tests in accordance with ANSI/IEEE Standard 43.
 - a) Motors larger than 200 horsepower: Test duration shall be for ten minutes. Calculate polarization index.
 - b) Motors 200 horsepower and less: Test duration shall be for one minute. Calculate the dielectric-absorption ratio.
 - 2) Test motor starter in accordance with Section 7.16 of these specifications.
 - 3) Verify that resistance temperature detector (RTD) circuits conform to drawings. Verify that metering or relaying devices using the RTD's have the correct rating.
 - 4) Verify that the motor space heater is functional.
 - 5) Perform a rotation test to insure correct shaft direction.
 - 6) Measure running current and evaluate relative to load conditions and nameplate full-load amperes.
10. Capacitors where shown on the drawings:
- a. Visual and Mechanical Inspection
 - 1) Compare equipment nameplate and data with drawings and specifications.
 - 2) Inspect physical and mechanical condition.
 - 3) Inspect capacitors for correct mountings and required clearances.
 - 4) Verify that capacitors are electrically connected in their specified configuration.
11. Low-Voltage Surge Protection Devices where shown on the drawings:
- a. Visual and Mechanical Inspection
 - 1) Compare equipment nameplate and data with drawings and specifications.
 - 2) Inspect physical and mechanical condition.
 - 3) Inspect for correct mounting and adequate clearances.
 - 4) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
 - 5) Verify that the ground lead on each device is individually attached to a ground bus or ground electrode.

12. Dry Type Transformers

- a. Air-Cooled, 600 Volt and Below (167kVA Single-Phase, 500 kVA Three-Phase and Smaller)
 - 1) Compare equipment nameplate and data with drawings and specifications.
 - 2) Inspect physical and mechanical condition.
 - 3) Verify that resilient mounts are free and that any shipping brackets have been removed.
 - 4) Perform insulation-resistance test. Calculate polarization index. Measurements shall be made from winding-to-winding and each winding-to-ground. Test voltages and minimum resistance.
 - 5) Verify that winding turns-ratio measurements and polarities are in accordance with nameplate.
 - 6) Verify that as-left tap connections are as specified.
- 13. Grounding Systems
 - a. Visual and Mechanical Inspection
 - 1) Verify ground system is in compliance with drawings and specifications.
 - b. Electrical Tests
 - 1) Perform fall-of-potential test or alternative in accordance with IEEE Standard 81-1991 on the main grounding electrode or system.
 - 2) Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and/or derived neutral points.
 - c. Test Values
 - 1) The resistance between the main grounding electrode and ground should be no greater than five ohms for commercial or industrial systems and one ohm or less for generating grounds unless otherwise specified.
 - 2) Investigate point-to-point resistance values which exceed 0.5 ohm.
- 14. Ground-Fault Protection Systems
 - a. Visual and Mechanical Inspection
 - 1) Compare equipment nameplate and data with drawings and specifications.
 - 2) Visually inspect the components for damage and errors in polarity or conductor routing.
 - 3) Verify tightness of all electrical connections including control circuits.
 - 4) Verify correct operation of all functions of the self-test panel.
 - 5) Verify that the control power transformer has adequate capacity for the system.
 - 6) Set pickup and time-delay settings in accordance with the settings provided in the coordination study. Record appropriate operation and test sequences as required by NEC Article 230-95.
 - b. Electrical Tests
 - 1) Verify that relay does not operate at 90 percent of the pickup setting.
- 15. Low-Voltage Cables: 600 Volt
 - a. Visual and Mechanical Inspection
 - 1) Compare cable data with drawings and specifications.

- 2) Inspect exposed sections of cables for physical damage and correct connection in accordance with single-line diagram.
 - 3) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
 - 4) Inspect compression-applied connectors for correct cable match and indentation.
 - 5) Verify cable color coding with applicable engineer's specifications and National Electrical Code standards.
 - b. Electrical Tests
 - 1) Perform a insulation resistance test on all cables.
16. Systems Function Tests
- a. Perform system function tests upon completion of equipment tests. It is the purpose of system function tests to prove the correct interaction of all sensing, processing, and action devices.
 - b. Develop test parameters for the purpose of evaluating performance of all integral components and their functioning as a complete unit within design requirements. Perform these tests.
 - c. Verify the correct operation of all interlock safety devices for fail-safe functions in addition to design function.
 - d. Verify the correct operation of all sensing devices, alarms, and indicating devices.

3.5 SUMMARY TEST REPORT

- A. Upon completion of testing of all electrical equipment, submit summary test report in a 3-ring binder with proper tabs and table of contents for review and approval.

END OF SECTION